Evidence synthesis in the biological and natural sciences: Discipline-specific challenges and opportunities for librarian engagement

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All co-authors have given approval to the final version of the manuscript. This study has been reviewed and received ethics approval by Brock University Social Sciences Research Services Ethics Board file number 25-118 GORDON.

ABSTRACT

Biologists and natural science researchers are increasingly using evidence synthesis research designs. Evidence synthesis research methodologies attempt to summarize research knowledge with a disciplinary perspective to ultimately inform policy formation and decisions. Co-investigators asked researchers to identify confidence levels, training experiences, research gaps, notable discipline-related issues, and how academic librarians can better support researchers using evidence synthesis as a research tool. This two-phased inquiry invited corresponding authors of 121 recent biological and natural sciences' evidence synthesis articles to participate in 1) a Qualtrics online survey and 2) a follow up interview. Sixty-five researchers completed a six-question survey instrument in December 2025 and January 2026. Four participants completed a four-question follow up email interview in February and March 2026 asking for further insight of preliminary survey results. An analysis of 121 biological and natural sciences review articles revealed that researchers were affiliated with a great number of international institutions, articles were published in 75 different journals, researchers used a variety of strategies to search scholarly databases (i.e., Web of Science, Scopus, Google Scholar, etc.), and a limited number of articles documented the use of grey literature sources. 42.1% (n=51) did not identify the use of any evidence synthesis conducting or reporting standards. Qualitative content analysis of survey textual data identified four findings: (1) "Inconsistency in training" of biological and natural sciences' evidence synthesis researchers; (2) "Negotiating quality or lack thereof" of published reviews; (3) "Influence of primary sources on evidence synthesis designs" when accommodating disciplinary peculiarities into research designs and reporting standards; and (4) "Emerging and unsettled: Evolving methodological identities" as biological and natural science evidence synthesis research methodologies mature to improve quality, minimize bias, adoption of research results and related policy. Study concluding remarks include recommendations for librarians to participate in evidence synthesis institutional and disciplinary coursework; actively participate in evidence synthesis research; connect with and support research teams throughout the evidence synthesis process; promote the use of quality conducting and reporting standards; offer library-based evidence synthesis discipline-specific workshops; and help researchers to critically evaluate the quality of their work. This research sheds light on disciplinary nuances in a way that will be relevant and useful for librarians who support and/or participate in these research communities.

KEYWORDS

Evidence synthesis; systematic reviews, academic libraries; biological and natural sciences; librarian support

INTRODUCTION

Evidence synthesis research, well-established in the health sciences, has accelerated in popularity in other disciplines. In the biological and natural sciences, evidence synthesis research publications have been on the rise since 2005 (Boice, 2019; Cooke et al., 2023; Park, 2025). While there are clear methodological guidelines for this type of research in the health sciences (e.g., Cochrane Handbook, JBI Library), this is not the case for many other scientific disciplines. In this vacuum, the merit of librarian support has been underrecognized. Researchers, and the academic librarians who support them, are challenged by minimal training, disciplinary nuances, and a lack of vetted evidence synthesis best practices.

Boice (2019) commented that, "There is a clear upward trend in both the number of systematic review articles being published and the number of conservation biology journals publishing them over the past 20 years" (p. 7). This upward trend is reflected in Figure 1 with the number of citations for evidence synthesis research designs in the biological and natural sciences increasing 114% since 2010, and 47% from 2000 to 2025.

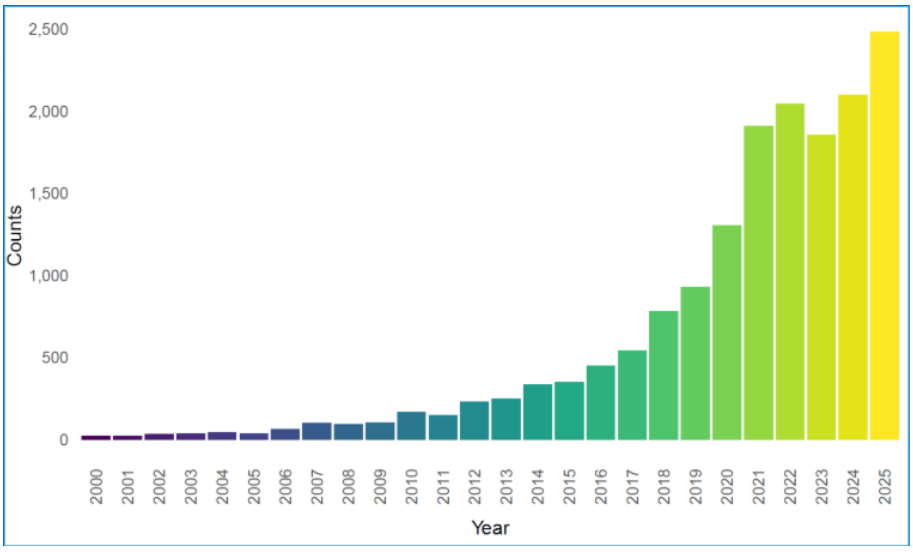

Figure 1. Clarivate Web of Science Complete Evidence Synthesis Biological Citations 2000-2025.

Clarivate Web of Science Complete databases: Web of Science Core Collection, Biological Abstracts, BIOSIS, BIOSIS Citation Index, BIOSIS Previews, Current Contents Connect, SciELO Citation Index, and Zoological Record.

Search strategy: Topic: ((meta or evidence or research) near/2 synthes?s or "meta analys*" or meta-analys* or meta*analysis or "meta synthes*" or meta-synthes* or meta*synthes* or "meta research" or meta-research or meta*research or (systematic or rapid or scoping) near/2 review or systematic near/2 map*) and Topic: (*environ* or *ecolog* or *biolog* or conserv*)) and Publication Years: 2000-2025 and Document Types: (Article or Review Article) and Research Area: Environmental Sciences & Ecology.

Evidence synthesis research designs identify, evaluate, and combine data from multiple primary studies to answer specific research questions in a structured way. Hallmarks of evidence synthesis research designs (e.g., systematic reviews) include strategies that attempt to ensure unbiased reporting, transparency of results, and reproducible methodologies. An excellent editorial titled "The Value of Evidence Synthesis" (2021) commented on the importance of the review literature as, "...a cornerstone of assessing research evidence on societally relevant questions to inform policy." These evidence-based studies integrally bring clarity and currency to decision makers and assist in the crafting of public policy. The success of evidence synthesis research projects, including in the biological and natural sciences, requires considerable expertise, time, and collaborative effort from discipline-specific research teams.

The involvement of librarians in evidence syntheses is known to increase their quality in a multitude of ways (Kallaher et al., 2020; Lê, Winkler & Neilson, 2024). Librarian and library support would be profoundly beneficial to evidence synthesis researchers outside of the health sciences; however, developing effective support strategies requires an understanding of researchers' disciplinary needs. In particular, academic librarians would value an increased understanding of what differentiates evidence synthesis in the biological and natural sciences from other disciplines, and researchers' relative confidence with different stages of the evidence synthesis process (Boden, Bolton & Gerrard, 2025; Scott & Vogus, 2022; Slebodnik, 2022).

This research study adopted a two-phased design to collect data from practicing researchers on their use of evidence synthesis research methodologies. A Web of Science database search identified current biological and natural sciences sample review articles (e.g. systematic reviews). These articles were further screened to note researchers' practices with respect to research designs, use of standards, observe researchers' affiliations, publishing, research design decisions, and interesting patterns (Dwivedi, 2026). Data collected from individual researchers included commentary on and description of experiences, choices, strategies, and resources related to disciplinary evidence synthesis research studies and publications. The first phase of the study involved collecting data from a purposive sample of biological researchers using an online survey tool. The second phase involved individual interview sessions with the purpose of reviewing preliminary survey results and exploratory questions. Qualitative content analysis of survey textual data generated findings and observations that will be of interest to librarians, researchers, and advocates of evidence synthesis research.

Two research questions included:

- What distinctions or peculiarities do researchers in the natural and biological sciences encounter using evidence synthesis methodologies?
- How can academic librarians best support researchers that utilize evidence synthesis research designs?

LITERATURE REVIEW

Evidence synthesis research methodologies in medicine and applied health sciences, and to a lesser extent, the social sciences draw upon a well-developed body of research tools and resources. These resources include conducting and reporting standards, frameworks, guidelines, scholarly articles, books, and web-based services. Institutes such as Cochrane, JBI, and the Campbell Collaboration

continually update resources in an ongoing effort to affirm the replicability, rigor, and transparency of evidence synthesis research investigations.

Conducting and reporting standards, also referred to as critical appraisal tools, checklists, and guidelines, are formalized criteria for evaluating the quality of evidence syntheses. Conducting and reporting standards as a collective of guides assist researchers to construct quality evidence synthesis reviews. These standards also aid readers of evidence synthesis projects to better critically evaluate published reviews and apply them to their own settings.

Conducting standards direct how a review research project is structured, managed, and executed (e.g. The Collaboration for Environmental Evidence (CEE)). These standards include established frameworks, guidelines, and methodological best practices used to plan, execute, and document review findings in an unbiased, transparent, and reproduceable manner. Reporting standards serve as guidelines for protocol and manuscript preparation to help ensure that reviews are complete and meet academic and publication standards (e.g. ROSES (Reporting Standards for Systematic Evidence Syntheses in Environmental Research)). In general, conducting standards guide how a study or project is designed whereas reporting standards govern how the completed process is documented and presented for transparency.

Some standards are broad and apply across disciplines, while others are designed for specific fields such as health sciences, education, or social policy. As review methodologies evolve, many standards are applied across different and diverse disciplines. Some scholarly journals, especially those associated with evidence synthesis institutes, require that conducting and reporting standards are followed based on the type of review. Conducting and reporting standards are excellent resources that help guide researchers to create effective reviews and communicate them clearly, maximizing impact.

Notable standards and resources of interest to evidence synthesis researchers in the biological and natural sciences include: Enhancing the QUAlity and Transparency Of health Research (EQUTOR), Conservation Evidence (Cambridge), Critical Appraisal Skills Programme (CASP) Checklists, LATITUDES Network, Collaboration for Environmental Evidence Synthesis Assessment Tool (CEESAT) checklist, Collaboration for Environmental Evidence Database of Evidence Reviews (CEEDER), Grading of Recommendations Assessment, Development and Evaluation (GRADE) Working Group, and Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA), including PRISMA-EcoEvo, and PRISMA 2020. Additionally, extensions to PRISMA are being published for a growing number of different review typologies (i.e., rapid, scoping, living system, meta-analysis, scoping), research communities, and disciplines.

A select list of conducting standards published as academic papers and utilized within biological and natural sciences reviews include: Arksey & O'Malley, 2005; Aromataris et al., 2024; Haddaway et al., 2018; Higgins et al., 2024; Higglefsen et al., 2021; James, Randall & Haddaway, 2016; Konno, Livoreil & Pullin, 2021; Nakagawa et al., 2023; Moher et al, 2009; O'Dea et al., 2021; Pullin & Stewart, 2006; Rethlefsen et al., 2021; and Tricco et al., 2018. These standards have helped researchers to apply evidence synthesis research designs to biological research questions and investigations. Yet, with significant progress gained over a relatively short period of time, there is a demand for more discipline-specific resources. Stanhope and Weinstein (2023) commented that, "New tools are needed that reflect a range of questions posed in ecology ...These tools should be comprehensively examined for their

validity and reliability... thereby enhancing the effectiveness of interventions and optimizing the use of limited resources for conservation and restoration" (p. 353).

Librarians have instrumentally contributed to the updating of conducting and reporting standards. They have provided instruction, workshops, books, articles, and supplementary resources on these standards, and evidence synthesis in general. Librarians have also been active as research partners, reviewers, contributors to institutional review resources, and providers of instructional resources (Laynor & Roth, 2022). The purpose of this literature review is not to review or critically evaluate these resources, but to comment on their disciplinary use and nature. This study, to co-investigators' knowledge, is one of the first investigations to examine evidence synthesis in the biological and natural sciences from a librarian perspective.

Boice (2019) commented on the value that librarians bring to this disciplinary practice, "...evidence of variable search quality and reporting indicates an important role for librarians in improving literature search strategies and documentation" (p. 1). Boice goes on to comment that a review of the literature contained, "...numerous examples of ambiguous reporting and incomplete literature searches" and that librarians are important when "...educating researchers on appropriate search and reporting methods, clarifying general systematic review methodology, and referring researchers to systematic review standards and resources as needed" (p. 8). Berger-Tal et al. (2018) affirm the importance of the instruction that librarians provide, commenting, "Making systematic evidence synthesis training part of the education process for graduate students and early career researchers ...can provide scientists with comprehensive knowledge of the evidence surrounding a specific topic, equip them with a set of tools to engage more effectively with other scientists and practitioners, and increase the validity of their own research" (p. 5). As evidence synthesis team members, librarians bring evidence synthesis expertise and experience from different disciplines. Librarians also bring a current state of knowledge to researchers' evidence synthesis research decision making, selection of reporting standards, methodological design, and execution (Ades, et al., 2013; Boden, Bolton, & Gerrard, 2025). An excellent editorial titled, "Why every scientist needs a librarian" (Dance, 2026) reflects on librarians' expertise and the many roles they play in supporting evidence synthesis research.

Through evidence synthesis, researchers in the biological and natural sciences identify 'what's been done', detect current patterns and themes, reviewing research, essential resources, and help direct future research (Belovsky et al., 2004; Smaldino & McElreath, 2016; Sutherland et al., 2004). The literature comments on complexities and nuances researchers may face within this discipline. These issues may affect researchers' decision making, adjustments to research designs, use of reporting standards, analyses, assessment, quality of reviews, reproducibility, and impact of results (Braun et al., 2025; Fazey et al., 2004; Grames & Elphick, 2020; Ioannidis, 2023; Pasquier et al., 2017; Wyborn et al., 2018). In an earlier study that compared the use of evidence syntheses in medicine and environmental management, Roberts et al. (2006) commented, "When compared with medical systematic reviews, ecological reviews were more likely to be prone to bias, lacking details in the methods used to search for studies, and were less likely to assess the relevance of studies, quality of the original experiments and to quantitatively synthesise the evidence" (p. 409). The quality of some biological and natural sciences evidence syntheses may be in question, but it is uncertain as to the reasons for this discrepancy. The etiology of lesser quality biological and natural sciences' reviews continues to be debated. Several nuances specific to biological and natural sciences' evidence synthesis reviews are highlighted in the literature. One of the

most important issues is the study of biology within a natural world. Biological systems can be tricky to investigate, making analyzing data, interpreting results, and reviewing findings more difficult in turn (De Cassai et al., 2025). Westgate and Lindenmayer (2017) identified semantic complexities when applying systematic review methodologies to complex and open biological and ecological research. Semantic complexities refer to the density, depth, and intricacy of meaning within language, data, or systems. Biologists and naturalists conducting research over space and time use a variety of scientific, formal and descriptive terms. These terms may have different meanings depending on the context of their use in natural language. As a result, effective evidence synthesis research needs to recognize semantic contextual meanings and differences in language within complex biological systems.

Biologists conducting reviews often deal with primary sources and variance in data when studying small sample sizes to demonstrate long range and larger phenomena (Møller & Jennions, 2002). “Biologists deal with living organisms under the influence of numerous biotic and abiotic interactions that alone, and in combination, influence whichever factor is under investigation. Thus, the predictive power of most fields of biology is considerably weaker than that in the more exact natural sciences (p. 493). Pullin and Knight (2009) further commented on the difficulty of making recommendations within big and holistic natural systems based on primary studies that utilized smaller sample sizes. Evidence synthesis researchers attempting to review biological and natural science literature are challenged by the prevalence of variable and small samples. Evidence synthesis studies in the biological and natural sciences can be limited in their usefulness, accuracy, and validity by knowledge gaps and poor evidence (Fraser et al., 2018; Pullin & Knight, 2001; Roche et al., 2022; Toomey, Knight & Barlow, 2017; Sabo et al., 2024).

Other nuances pertinent to evidence synthesis of research on biological and natural systems include the heterogeneity of biological data, large volumes of data, and data that addresses complex and location-specific research questions (Berger-Tal et al., 2018; Elliott-Graves, 2025; Nakagawa & Lagisz, 2019; Pullin et al., 2004; Senior et al., 2016). The incorporation of grey literature sources into review narratives is also a topic of disciplinary interest (Bonato, 2018; Kugley & Epstein, 2018). Grey literature sources are a key source for systematic reviews in the biological and natural sciences (Haddaway & Bayliss, 2015); however, “Systematic review searches for grey literature can be particularly challenging and time consuming” (Haddaway, 2015b, 186). Researchers are also challenged by the necessity of including framing analyses, using complex statistical measures (Cooke et al., 2020), and the disentanglement of data used for analysis within complex and intertwined ecological systems (Madliger et al., 2021). Additionally, parsing data within selected primary studies requires careful consideration of the original research and writing. How researchers frame their studies and capture data varies greatly within and across different biological systems.

Additional concerns may include: a lack of appropriate comparators when studying natural ecosystems (Coxon, Longstaff & Burns, 2019); connectivity issues (UNEP-WCMC, 2023); treatment of confounding variables (McDonald, 2014); argumentation within natural systems (Rebello, Asunda & Wang, 2020); insufficient transparency, reliability and critical appraisal of research methodologies, publication and selection biases (Haddaway et al., 2015, Martin et al., 2023; Mupepele et al., 2016; Parker et al. 2016; Pullin et al., 2022; Romanelli et al., 2021); a lack of appropriate critical appraisal of included studies (McIntosh et al., 2017; Stanhope & Weinstein, 2023); and a favor of certain kinds of evidence over others (Haddaway & Pullin, 2014).

Methodological disciplinary challenges may include selection of discipline-specific databases for literature searches (Gusenbauer & Haddaway, 2020), deficiencies of training of new and student researchers (Downey et al, 2021), a rapidly growing literature base that outpaces reviews (Ayambire et al., 2024; Downey et al., 2022), the difficulty of addressing government policy making (Nyboer et al., 2021; Thomas-Walters et al, 2021), and navigating evidence bridges between researchers and practitioners (Kadykalo et al., 2021; Segan et al., 2011; Stevens & Norris, 2022; Walsh, Dicks & Sutherland, 2015). A nuance of interest to all researchers is the considerable time, effort, and cost to successfully conduct evidence synthesis reviews in the biological and natural sciences (Collins, Coughlin & Randall, 2019; Haddaway & Westgate, 2018).

Co-investigators could not identify recent biological or natural sciences' textbooks that described evidence-based or evidence synthesis research designs or methodologies. Although evidence synthesis research methodologies, including meta-analysis, have been essential parts of medicine, social sciences, and applied health texts and handbooks for some time, this absence in discipline-specific resources could be a call to action for researchers and publishers. Researchers exploring interdisciplinary evidence synthesis research designs (Adams, 2016; Nowell et al., 2022) noted additional challenges and the need for standards and guides that support multidisciplinary and complex research investigations.

The use and effectiveness of artificial intelligence (AI) based software and related algorithms is in its infancy. Current exploratory research is investigating the ethical use of AI systems without threatening research integrity (Arar et al., 2025; Siemens et al., 2025), critically evaluating opportunities to automate various evidence synthesis steps, potentially increasing efficiency and reducing costs (Bolaños et al., 2024; Sousa et al., 2026), improving search logic (Eastaugh, et al., 2025), and improving library services to support evidence synthesis researchers (Georgieva & Georgieva, 2025). Berger-Tal et al. (2024) commented that "...when judiciously used, AI has the potential to speed up and hopefully improve the process of evidence synthesis, which can be particularly useful for underfunded applied fields, such as conservation science" (p. 548). Librarians supporting evidence synthesis researchers are well placed to debate the merits of AI-driven databases, systems and software, advocating for responsible use and high-quality research (Flemyng, et al., 2025).

Co-investigators through this literature review have identified effective conducting and reporting standards, and resources that can help researchers in the biological and natural sciences to improve the quality and reliability of reviews. A select list includes resources that speak to quality measures (O'Leary et al., 2016; Woodcock, Pullin & Kaiser, 2014), identify guidelines (Foo et al., 2021; Kolaski, Logan, & Ioannidis, 2023), use checklists and reporting standards (Haddaway et al., 2016; Livoreil et al., 2017; Pullin, et al., 2022), and consider best practices (Cherry, Boland & Dickson, 2024; Dekkers, Drylie Carey & Langhorne, 2022; Foster & Jewell, 2022; Nyboer et al., 2025; Pullin et al., 2020; Sunderland, 2022). Exceptional resources continue to be published on a regular basis. Examples include, two Open Educational Resources (OERs), one for conservation management (Sutherland, 2022), and another for crafting effective systematic reviews (Dermondy et al., 2022). Traditional handbooks include the Cochrane Handbook (Higgins et al., 2024) and the Cochrane-Campbell Handbook for Qualitative Evidence Synthesis (Noyes & Harden, 2024).

The literature addressing evidence synthesis in the biological and natural sciences is relatively new when compared to the medical, social and health sciences. The researchers working in this area are

demonstrably committed to enhancing both the quality and applicability of evidence synthesis as it continues to increase in popularity as a research design.

METHODOLOGY

Research Design

This study included two phases. The first phase involved collecting data using an online survey tool, Qualtrics. The survey asked participants to self-identify their status or position, evidence synthesis confidence levels, training, and unique characterises of conducting evidence synthesis research in the biological and natural sciences. The second phase of this study was initiated shortly after the completion of the first phase survey. Interview sessions were conducted by email, inviting survey participants to respond to a series of open questions. Interview questions primarily focused on reviewing preliminary survey results. As per ethics guidelines, the study's primary investigator coordinated all survey and interview sessions, aggregated numerical data, and redacted text that might identify participants or their institutions. Qualitative content analysis of textual data and scrutiny of aggregated numerical data resulted in the identification of several study findings and observations. Drawing from personal experience as library professionals and evidence synthesis practitioners, co-authors crafted commentary and concluding remarks to provide further insight into how academic librarians can provide effective evidence synthesis support to biological and natural science research teams.

One hundred and fifty of the most relevant published academic evidence synthesis papers were identified using a Clarivate Web of Science Complete database search. The database search strategy was executed in December 2025, and is reported as Appendix A. Searching the Web of Science database, "relevance" was defined as a measure of how closely a search result matches the user's query, primarily determined by an algorithm that analyzes and ranks citations according to the frequency and location of search terms within the metadata. Web of Science uses a combination of keyword frequency, semantic understanding (Smart Search), and user-behavior data (related records) to define the most relevant academic literature for a query.

There are a wide variety of evidence synthesis research designs (Cook et al., 2017; Covington, 2025; Nussbaumer-Streit et al., 2025; Sutton et al., 2019). Co-investigators agreed to focus this study on investigating systematic review papers and similar designs (e.g., scoping reviews). Systematic reviews are widely accepted as a 'gold standard' in evidence synthesis (Haddaway, 2015a). This decision may have helped normalize researchers' experiences by focusing on the same evidence synthesis design across the entire sample of articles. This focus included systematic review papers that implemented additional or secondary analysis techniques (e.g., meta-analysis). Co-investigators agreed to limit the number of articles investigated to 150, a purposive sample size for this type of study.

Prior to the fabrication of the study's survey instrument, the principal investigator reviewed all 150 evidence synthesis articles. Upon closer examination 29 of these 150 articles were withdrawn from the sample based on their type of review design not being a systematic review and/or their subject focus falling outside of the biological or natural sciences. This resulted in a sample set of 121 articles. Twenty-seven of these 121 articles included additional review methodologies such as literature reviews, meta-analysis analysis, systematic review proposals, systematic reviews with bibliometric analysis, scoping reviews, and systematic mapping reviews.

Corresponding author(s)' contact information was gathered from all identified sample papers. Invitations including the corresponding article citation, a link to the survey instrument, and relevant supporting documentation were emailed to corresponding authors by the principal investigator in December 2025. Potential survey participants were asked to provide consent and complete the questionnaire in a timely manner, encouraged to share the survey invitation with co-authors, and prompted to respond by email if they were interested in participating in the second phase of the research study.

All aspects of this research study were vetted and approved by the Brock University Research Ethics Social Sciences Research Board.

Survey Design and Research Questions

The first phase of this research study used a survey instrument that asked participants to comment on their experiences as evidence synthesis researchers in the biological and natural sciences. Given that the study sample was drawn from the authorship of English-language articles, the survey was only made available to participants in English. The survey email message included introductory comments, instructions, ethics-related guidelines, the principal investigator's contact information, and a link to the online survey questionnaire. The first of six questions asked participants to provide consent. Once consent was provided, participants were able to respond to the remaining five survey questions. The Qualtrics survey instrument captured participants' data using a variety of closed, open, and ranking survey question formats. One demographic question asked participants to identify their position or status as faculty, staff, student, or other. Two Likert scale questions asked participants to rate their level of confidence conducting evidence synthesis research. Two open response questions asked participants to comment on their training, and distinguishing factors of conducting evidence synthesis research in the biological and related sciences.

A copy of the survey instrument is available as Appendix B.

Interview Design and Research Questions

The second phase of this research study invited eight potential participants to respond to a series of open questions. Participants were identified by responses to survey instrument email invitations or by an email invitation to key member(s) of the biological and natural sciences evidence synthesis research community. These questions were based on aggregated and redacted preliminary survey results. Participants were asked by email to provide consent, review survey textual and numeric data, and respond to four questions. Email interview questions included,

- Survey data indicates that a significant number of evidence synthesis researchers in the biological sciences are confident in their abilities to conduct evidence synthesis research. Is this your experience?
- What training strategies should researchers take to improve the quality of biological evidence synthesis research?
- What value does evidence synthesis research bring to the biological and related sciences?
- Have you considered bringing a librarian on to your next evidence synthesis research team? If so, what would this look like?

Analysis of Sample Articles

Clarivate Web of Science database analysis of the sample of articles identified a total of 625 authors and 139 corresponding authors. Further Web of Science analysis identified all authors' institutional addresses representing 63 countries. The seven most frequently represented national institutional addresses were: Canada, United States, Australia, Peoples Republic of China, England, Germany and Spain. Eighty four percent of sample articles were published in 2024 or 2025. The remaining 16% of sample articles were published immediately prior to 2024. Sixty six percent of articles were designated as being published as open access. Sample articles were categorized by 58 different Web of Science major concepts. The most prevalent major concepts included: Conservation, Ecology Environmental Sciences, Wildlife Management, Biodiversity, Anthropology, Environmental Sciences, Human Ecology, and Pollution Assessment Control & Management. Sample articles were categorized by 75 different Web of Science Research Areas. The most prevalent research areas included: Environmental Sciences Ecology, Biodiversity Conservation, Marine Freshwater Biology, Zoology, Public Environmental Occupational Health, and Science Technology Other Topics. Sample articles were published in 93 different journals. The journals representing the most sample articles included: *Environmental Evidence, Biological Conservation, Diversity, Journal of Environmental Management*, and *Conservation Biology*.

The principal investigator reading each of the 121 sample articles documented the number and names of databases researchers used when executing literature searches. A majority, 71.9% of articles (n=87) used Web of Science, 56.2% used Scopus (n=68), 43.0% used both Web of Science and Scopus databases in the same research study (n=52). A minority, 24.0% used Google Scholar (n=29), 11.6% used PubMed or MEDLINE (n=14), and 6.6% used ProQuest Dissertations and Theses Global (n=8). Sample article researchers did not provide any justification as to their choice of databases when conducting comprehensive literature searches across multiple databases. Additional databases used for literature searching in sample articles included, Google, national databases, e.g., China Academic Journals (中国学术期刊), publishers' databases, e.g., Science Direct, government databases, e.g., science.gov, Artificial Intelligence (AI)-assisted databases, e.g., Bielefeld Academic Search Engine (BASE), Semantic Scholar, Elicit, and Dimensions.

Most researchers documented database search strategies that used a series of keywords, Boolean operators (i.e., AND, OR, NOT), and techniques to combine key concepts. An alternate search strategy documented in several sample articles included searching Google Scholar and capturing the first 150, 200, or more articles ranked by relevance before screening by pre-defined eligibility criteria. It was also observed that some researchers manually added citations found while browsing institutional web sites, government databases, theses, dissertations, government and/or institutional reports. Other researchers browsed cited references of highly relevant articles, reviews, and reports, adding individual citations to pre-screening lists one at a time. Some researchers reviewed and manually added articles that cited highly significant articles. Others identified articles through forward citation searching techniques (e.g., Google Scholar "Cited by"). A limited number of researchers identified articles generated by AI software, or articles from source lists generated by AI software (e.g. Undermind, Google NotebookLM, and ChatGPT). Some researchers documented a strategy that uploaded large lists of citations and abstracts to AI-based software that ranked the most relevant articles based on textual analysis ranking algorithms. It is uncertain whether other research teams may have performed similar analyses but failed

to identify their use of AI to identify relevant articles in their study's methodology. Most researchers did not justify why alternate strategies were used or how useful they were in capturing relevant articles and resources when crafting evidence synthesis research designs.

There was a notable range of number of literature sources (e.g., articles) used by sample articles for eventual analysis. Most research teams conducting systematic reviews "...seem to always whittle these down to around 12-15" citations (Gray, 2020, 27). Another study (Borges Migliavaca et al., 2020) calculated the median number of studies included in each review as 24. The number of literature sources identified for analysis documented in this study's sample articles was a minimum of 8, maximum 2,981, mean 226, median 91, mode 56, standard deviation 380, relative standard deviation 168, and mean absolute deviation 221. Co-investigators, although curious, did not explore how this sample set's range of articles identified for further analysis compared with reviews in other types of research designs or subject areas.

Grey literature sources are important to most conservation, ecology, restoration, and applied biological studies (Haddaway & Bayliss, 2015). Twenty-six sample articles noted the value of grey literature sources to evidence synthesis research, particularly when research questions were related to policy decisions. However, only eight sample articles included grey literature sources in their literature reviews. Most papers did not incorporate nor provide justification for their lack of incorporation of grey literature in their evidence synthesis documentation.

The use of conducting and reporting standards is key to creating quality evidence synthesis studies. Co-investigators were particularly interested in the use (or lack thereof) of conducting and reporting standards in sample articles. Reading all sample articles, the principal investigator found that 42.1% (n=51) did not identify the use of any evidence synthesis conducting or reporting standards. It is unclear what strategies were or were not used in these studies to ensure the validity and thoroughness of evidence synthesis methodologies or reporting. The remaining 57.9% (n=70) of survey articles identified at least one or more standards. The frequency of standards documented at least two times in all sample articles is outlined in Table 1. A list of standards identified once in sample articles includes: Higgins et al, 2019; James, Randall & Haddaway, 2016; Linares-Espinós et al., 2018; Mishra & Mishra, 2023; and Peters et al., 2021. Notably, the principal investigator observed that no researchers justified why they selected the standard(s) they chose or why they did not document any standards as part of their research design.

Standard	Number of studies	Percent of 70 reporting studies
Page et al., 2021a, 2021b, (PRISMA)	22	31.4
PRISMA 2020	10	14.3
Haddaway et al, 2018, (ROSES)	9	12.9
Moher, 2009	7	10.0
Konno, Livoreil & Pullin, 2021, (CEE)	7	10.0
Pullin & Stewart, 2006	6	8.6
Tricco et al., 2018	6	8.6
Rethlefsen et al., 2021	4	5.7
Aromataris et al., 2024, (JBI)	2	2.9
Higgins et al., 2019	2	2.9
Arksey & O'Malley, 2005	2	2.9
James, Randall & Haddaway, 2016	2	2.9

Table 1. Standards cited in sampled evidence synthesis articles.

Analysis of Survey Results

First phase open survey questions invited participants to comment on their experience using evidence synthesis research designs. This metadata as numerical and textual data formed the basis of study results and discussion. Textual data was analyzed using qualitative content analysis techniques (Kuckartz & Rädiker, 2023). Numerical data was analyzed to identify statistical frequencies, means, averages, etc.

Survey questions 3 and 5 asked participants to rate their confidence levels to conduct evidence synthesis-based research using a five-point Likert scale: a scale of 1 (not confident at all) to 5 (Extremely confident). Co-investigators grouped the frequency of participants' responses to better estimate more and less confidence. This study's measure of "Less Confidence" was determined by combining Likert scale responses 1 or 2. "More Confidence" values were determined by combining Likert scale responses four or five. Survey participants selecting Likert scale response three was interpreted by co-investigators as participants that were somewhere in the middle – neither more nor less confident.

Analysis of Interview Results

Second phase interview semi-structured questions, intended to provide additional insight into survey findings and interpretation, were not analyzed using a structured methodology. Instead, this textual data was taken into consideration when crafting this study's findings, observations, discussion and concluding remarks.

RESULTS

Survey Results

This study's first phase, a survey, garnered 65 total responses. Participants were invited to respond to all questions, but no questions were mandatory, resulting in response rates that varied by question. The survey asked participants to comment on two open survey questions. These two questions generated 97 comments, comprising approximately 2,789 words.

The 64 participants that responded to the survey question about position or status (Question 2) were: faculty, 37.5% (n=24); student, 31.3% (n=20); staff, 15.6% (n=10); and other, 15.6% (n=10). Participants selecting the "other" category self-identified as: recent grad, consultant, postdoc, postdoc researcher, head of environmental NGO and postgraduate student, government consultant, research assistant, NGO scientist, and government policy consultant.

Participants used a 5-point scale to rate their confidence conducting evidence synthesis research (Question 3), summarized by Table 2. 72.3% (n=47) of participants rated their confidence levels as more confident and 12.3% (n=8) as less confident.

Confidence Level	1	2	3	4	5	More confident%	Less confident%	n
Responses	1	7	10	30	17	72.3	12.3	65
Percentage	1.5	10.8	15.4	46.2	26.2			

Table 2. Survey Participants' Confidence Levels to Conduct Evidence Synthesis-Based Research.

On a scale of 1 (not confident at all) to 5 (Extremely confident), how would you rate confidence in your ability to conduct evidence synthesis research?

Less confident was calculated by participants selecting stages of evidence synthesis Likert scale confidence levels 1 or 2. Less confident percentages equal less confidence value frequencies 1 + 2 / n x 100%. More confident was calculated by participants selecting Likert scale confidence levels 4 or 5. More confident percentages equal more confident value frequencies 4 + 5 / n x 100%. Percentages generated by Qualtrics software may not equal 100%.

Qualtrics software was used to benchmark participants' confidence with evidence synthesis research techniques (Question 3) against their position or status (Question 2), with the resulting breakdown highlighted in Table 3. Considering the average confidence scores of each position/status group, faculty were more confident than staff, students and others conducting evidence synthesis-based research.

Confidence Level	Rank	Average score	1	2	3	4	5	n	%
Status									
faculty	1	4.08	0	2	4	9	10	35	53.8
staff	2	3.90	0	1	2	4	3	10	15.4
students	3	3.75	0	3	2	12	3	20	30.8
other	4	3.40	1	1	2	5	1	10	15.4
total		3.85	1	7	10	30	17	65	

Table 3. Ranked Survey Participants' Confidence Levels by Position or Status to Conduct Evidence Synthesis Research.

> On a scale of 1 (Not confident at all) to 5 (Extremely confident), how would you rate confidence in your ability to conduct evidence synthesis-based research? Percentages generated by Qualtrics software may not total 100%.

Participants rated their confidence level (Question 5) with 12 stages of evidence synthesis research on a 5-point Likert scale. Table 4 captures participants' data ranked by stages of evidence in chronological order of evidence synthesis workflows. Table 5 captures data ranked by stages of evidence in decreasing order of confidence levels. A majority of participants selected Likert scale confidence levels 4 or 5 for 7 of 12 stages (58.3%). These stages included: quality of data assessment, risk of bias assessment, discerning impact of resulting research, synthesizing, mapping or describing results, creating database search strategies, selecting grey literature sources, and data selection. Most participants selected Likert scale confidence levels 1 or 2 for 5 of 12 stages (32.7%). These stages included: citation/export screening management, drafting research questions, selecting databases, article/citation screening, and developing and registering protocols.

	Confidence Levels						
	1	2	3	4	5	n/a	n
Stages of evidence synthesis research							
Developing and registering protocols	5	15	22	11	8	4	65
Draft your research question(s)	8	21	24	9	3	0	65
Select databases	11	23	16	9	4	0	63
Select grey literature sources	3	10	16	18	12	6	65
Create database search strategies	1	13	24	11	15	1	65
Citation / export management	10	26	17	7	3	2	65
Article / citation screening	5	20	21	12	6	0	64
Data selection	5	12	13	26	8	1	65
Risk of bias assessment	0	9	12	23	14	6	64
Quality of data assessment	1	3	16	20	20	5	65
Synthesize, map or describe results	4	9	17	23	9	3	65
Discern impact of resulting research	2	9	23	10	20	1	64

Table 4. Survey Participants' Confidence Levels to Conduct Stages of Evidence Synthesis Research

On a scale of 1 (not confident at all) to 5 (Extremely confident), how would you rate confidence in your ability to conduct evidence synthesis research? n/a = not applicable.

	Less confident %	More confident %	Table 5 n-n/a
Stages of evidence synthesis research			
Quality of data assessment	6.7	66.7	60
Risk of bias assessment	15.5	63.8	60
Data selection	26.6	53.1	64
Synthesize, map or describe results	21.0	51.6	62
Select grey literature sources	22.0	50.8	59
Discern impact of resulting research	17.5	47.6	63
Create database search strategies	21.9	40.6	64
Developing and registering protocols	32.8	31.1	61
Article / citation screening	39.1	28.1	64
Select databases	54.0	20.6	63
Draft your research question(s)	45.0	18.5	65
Citation / export management	57.1	15.9	60

Table 5. Ranked Survey Participants' Confidence Levels to Conduct Stages of Evidence Synthesis Research Ranking

On a scale of 1 (not confident at all) to 5 (Extremely confident), how would you rate confidence in your ability to conduct evidence synthesis research?

Less confident was calculated by participants selecting stages of evidence synthesis Likert scale confidence levels 1 or 2. Less confident percentages equal less confidence value frequencies 1 + 2 / n x 100%. More confident was calculated by participants selecting Likert scale confidence levels 4 or 5. More confident percentages equal more confident value frequencies 4 + 5 / n x 100%. Percentages generated by Qualtrics software may not equal 100%. Ranking was determined by more confident percentage values. Percentages generated by Qualtrics software may not total 100%.

Responding to the survey question "What training e.g. course(s), seminars, informal learning… informed your understanding of evidence synthesis research practices?" (Question 4), participants described a wide variety of experiences. The 64 responses to this question ranged from no official training to certification

as an evidence synthesis trainer. A participant, commenting on their lack of training, wrote that they were "...mostly shooting from the hip." Some participants commented on attendance at formal seminars, certified workshops, conferences, symposium, and previous coursework as experiences through which they gained expertise in evidence synthesis research. A few participants identified as experts or trainers, sharing that they had extensive experience with evidence synthesis research. However, most participants commented that their expertise was gained through informal leaning, reading the literature, and/or mentorship by senior faculty and team members.

Co-investigators noted the extent and thoughtfulness of participants' responses to, "What is notable or unique when conducting evidence synthesis research specifically in the biological and natural sciences?" (Question 6). Most of the 64 responses addressed some of these themes: The difficulty of this research methodology, strategies to increase the validity of results, minimizing bias, reliability of analytical tools to evaluate data, and the unique nature of biological data. A participant commented on the value of evidence synthesis research designs, "...evidence synthesis has a disciplinary bias, is not perfect, but fills a huge research hole when directing policy, recommending change, and sustainability." Another participant commented on the difficulty of analyzing data in the biological and natural sciences, "The variation in data collection and measurement can make it challenging to compare like with like." The newness and growing pains of evidence synthesis in the biological sciences was raised, with one participant commenting, "There are no real official training material or resources for conducting a valid biological study, so we borrow from health sciences which is fair, but not appropriate when using an ecological lens and discerning data to find good answers to difficult research questions!" Relatedly, another participant commented, "Lots of issues with study quality - e.g., lacks replication, failure to include comparator - that makes quantitative analysis (meta-analysis) difficult and thus means often times having to lean solely on narrative synthesis."

A redacted list of participants' responses to survey questions 3 and 5 is available as a supplementary document, https://archive.org/details/evidence-synthesis-in-the-biological-sciences-survey-questions-3-and-5-textual-data.

Interview Results

Four participants (50.0%) responded to email interview questions in February and March 2026. Participants redacted responses collectively included 19 comments comprising of approximately 1,444 words. A full list of interview participants responses is included as Appendix C.

DISCUSSION

Qualitative content analysis of survey comments by corresponding authors of recently published biological and natural sciences peer-reviewed scholarly articles generated four findings and related observations. Participants identified themselves as fairly confident of their abilities to conduct most stages of evidence synthesis research. A typology of corresponding authors could be best described as a class of established, senior and competent researchers. Researchers were found to support mentoring roles to team members, leadership, oversight, and acted as overseers for research design, quality control, searching, screening, assessment and discerning the impact of their research. Other survey participants could be described as researchers and classified as co-investigators, evidence synthesis collaborators, evaluators of research data, and/or study reporters. Researchers could have taken on different responsibilities as valued team members. Relationships between contributing corresponding authors and research team members

could vary depending on their status as graduate students, staff members or contributing members as consultants, postdoc researchers, NGOs, scientists and/or members of government bodies.

Textual data derived from survey question 3, “What training e.g. course(s), seminars, informal learning… informed your understanding of evidence synthesis research practices?” (n=67), and survey question 5, “What is notable or unique when conducting evidence synthesis research specifically in the biological and natural sciences?” (n=67) was analyzed to identify findings and observations. Co-investigators explored several different social science qualitative analysis methodologies that could be used to identify emergent themes and patterns prior to taking on this part of this study. As an exploratory study attempting to identify relevant patterns and themes, co-investigators selected Kuckartz & Rädiker (2023) as an appropriate analytical methodology to review this study’s survey textual data. This methodology, “...allows for the thematic analysis of guideline-oriented, problem-centred, focused, as well as many other types of [data]” (Kuckartz & Rädiker, 2023 Chapter 5, p. 4). Textual data was coded deductively with categories developed from study research questions and state of the research. Analysis was supplemented when appropriate by interview data derived from interviews of four survey participants responding to four exploratory questions.

Ultimately, analysis of survey data offered insight into the distinctions or peculiarities encountered by researchers in the natural and biological sciences when using evidence synthesis methodologies. These insights were further contextualized by interview comments, with rich descriptions allowing for the generation of observations about the relevance of these distinctions or peculiarities to the academic librarian.

Inconsistency in Training

Content analysis found that most survey respondents learned about evidence synthesis research *by doing*, not through formal education or training. There is a predominance of informal and experiential learning pathways. Participants commented on their learning happening “through extensive publication experience” and “self-study”, including reading "examples of other published surveys”.

Mentorship and collaboration also played a significant role in the learning process. In one case, a participant highlighted being “Trained directly by an expert in research synthesis”; however, for many participants, training was more informal, including “Informal learning with [their] senior colleagues”, discussions with “mentors, peers, etc.”, and working as part of a team.

Though rarely noted in the survey textual data, formal coursework was described as brief, superficial, and tangential to broader research methods certification and courses (e.g., Collaboration for Environmental Evidence (CEE)).

Evidence synthesis expertise gained through formal certification programs, workshops and publications is valued – one interviewee commented that additional training and certification “…brings rigor and transparency to what the researchers are doing and communicating”. Nonetheless, most participants indicated that their expertise is largely apprenticeship-based. This implies a dependence on access to knowledgeable collaborators rather than institutionalized training. Further research should explore the possible inequities this approach generates between well-connected research groups and those without access to expert knowledge networks. The creation of additional or certified training opportunities might

mitigate these inequities and enhance consistency among evidence synthesis research projects in the biological and natural sciences. As an interviewee commented:

Research training experiences are as diverse as any academic training program… It is the responsibility of research teams to be qualified, meet disciplinary standards and face the wrath of scholarly peer review… Being confident in evidence-based research in environmental and biological applications takes time, energy, patience, and the ability to see low quality for what it's worth… This would take our research community to push for these standards over time if only to improve the quality and impact of research on decision-making.

Negotiating Quality or Lack Thereof

Survey results indicate that the development and use of evidence synthesis research techniques in the biological and natural sciences lacks the same development and critical analysis as in the medical, social, and health sciences. Without the benefit of a longer history of critical conversations and refinements tailoring these research designs to their fields, biological and natural science evidence synthesis research seems to be more vulnerable to inconsistency and uncertainty.

There is a perceived gap in structured, discipline-specific guidance for evidence synthesis research methodologies. When research tools are not well aligned with the questions they seek to answer and/or data they seek to analyse, it can cause a study to produce skewed or subpar results. Existing frameworks developed by the health and medical sciences (e.g., PRISMA, Cochrane, JBI) are viewed as helpful but imperfect fits for the complexity and nuances of evidence synthesis research in this field – as one survey participant commented: "There are no real official training material or resources for conducting a valid biological study, so we borrow from health sciences which is fair, but not appropriate when using an ecological lens and discerning data to find good answers to difficult research questions".

The literature to be synthesized was identified as a potential limitation to synthesis quality by many participants. As participants noted, "there are questions as to the validity, bias, and quality of data that come from these studies that mitigates its impact", and "Evidence synthesis is only as strong as the primary literature". Weaknesses in the relevant literature can impact an evidence synthesis project. Additionally, several participants perceived that the nature of research in the biological and natural sciences might present difficulties for the synthesis process. As one participant commented:

The basis of evidence synthesis work in the biological and ecological sciences is the quality of data gleaned from independent scholarly peer-reviewed publications and reports. If the data is incomplete or fails to be reliable - then there isn't anything evidence synthesis can do to make the analysis whether quantitative or qualitative any better or more trustworthy. I think natural systems have a lot more variability between them especially in environmental systems, where there is a lot less of an ability to control things in an experimental way. So, comparing research across different environments can be very complex and you must be more cautious on what you can claim the impact of this type of review to be.

The lack of best practices tailored for the biological and natural sciences is thought to impact the quality of evidence syntheses produced in these fields. Researchers suggest that if disciplinary tools were available, the quality and impact of evidence synthesis research in the biological and natural sciences. Examples of possible tools include textbooks, open handbooks, certification processes, and/or course materials. The importance of quality in evidence synthesis research in the biological and natural

sciences was related by some study participants to its purpose. For example, an interviewee commented on the "important role for evidence-based research designs to create effective interventions over a wide swath of biological, ecological and conservation issues. The advent of climate change, invasive species, destruction of habitats, biological markers for change… are a few issues where evidence-based research is needed if we are to pursue value in making right decisions".

Influence of Primary Sources on Evidence Synthesis Designs

There is a lot of heterogeneity in biological research – which is not incidental, but structural to the field, given the variety of classifications, environments, and research topics explored. Heterogeneity in research designs refers to the variability or differences in study characteristics - such as population, intervention, data, analysis, methodology, or outcomes. Researchers conducting evidence syntheses are faced with choosing analytical methodologies that best report research findings. It is difficult to measure for quality control purposes which analytical means are less or more forgiving when attempting to increase the validity and minimize bias of biological and natural sciences, due to the heterogeneity of the research to be synthesized. For example, one participant commented that "In Conservation Biology the range of methods used to research a particular topic (e.g. the effectiveness of policy instruments) is so broad that it is often hard to synthesize research findings". The intersection of research findings, heterogeneous natural systems, and less than adequate data may yield to researchers' reliance on narrative synthesis. The diverse study designs, taxa, climates, geographies, and contexts present in biological and natural sciences research results in difficulties of comparing effect size, analyses, and context-dependent limits, comparison necessary for the generalization of findings.

An additional consideration for evidence syntheses in the biological and natural sciences is the inclusion of grey literature sources. One survey participant commented, that "unique in the biological and natural sciences is that relevant studies are often conducted by government, NGOs, or as part of environmental impact assessments". This presents challenges related to the identification, incorporation, critical evaluation and synthesis of evidence from these grey literature sources such as government reports.

Emerging and Unsettled: Evolving Methodological Identities

Evidence synthesis in biological and natural sciences is still evolving. As one interviewee commented:

Evidence-based ecology, conservation and environmental management is relatively new. The body of evidence is slim at times, the quality of studies is suspect, and resulting studies aimed at government bodies is so new for most decision-makers they don't know what to do with it… This will take time to turn this culture around. There is an important role for evidence-based research designs to create effective interventions over a wide swath of biological, ecological and conservation issues…

Unsurprisingly given that participants in this study were identified from their authorship of evidence synthesis research papers, they generally spoke positively of the methodologies; however, there was some recognition that consensus on these research designs has not yet been reached in the field broadly. One survey participant commented that "There is a lot of misinformation on this research design, some researchers don't call it science, while others call it the leading edge of qualitative assessment going forward. Who's right?".

Researchers continue to negotiate the use, quality, and applicability of conducting and reporting standards. There is a strong call for community-negotiated standards and evidence synthesis tools that more effectively align with biological and natural sciences' research, data, and knowledge systems. Despite perceptions of bias, ambiguity, and contradiction as inevitabilities, researchers are aspiring to develop methodologies that simultaneously accommodate biological and natural complexities and mitigate the risks that they pose to the integrity of evidence syntheses.

Evidence synthesis researchers expect that expertise should improve over time despite disciplinary challenges, and see these research designs as having immense potential, as one interviewee commented, for the "creat[ion of] effective interventions over a wide swath of biological, ecological and conservation issues".

Concluding Remarks

Evidence synthesis provides value to research by systematically gathering, appraising, and combining findings from multiple studies to create a comprehensive, reliable, and actionable overview of a topic. Evidence-based research assists researchers often transforming a vast, often contradictory sea of individual studies into usable knowledge, reducing bias and enabling evidence-based decision-making in policy, practice, and future research. Researchers in the biological and natural sciences using these methodologies are challenged by disciplinary distinctions, nuances, and peculiarities that may affect the quality and applicability of these evidence syntheses. Key issues worthy of further investigation include: the importance of grey literature sources, the diverse nature and number of databases used to identify review resources, and the applicability of available evidence synthesis' conducting and reporting standards.

Librarians are well positioned to continue to support and/or participate in evidence synthesis research teams. Staying abreast of different evidence synthesis research methodologies, reporting standards, and evidence synthesis training opportunities are paramount of importance to remaining current when working with evidence synthesis researchers and their teams. Librarians should continue to be open to conversations that support quality syntheses. These syntheses have the impact to direct meaningful decision making and effective policy development.

Recommendations to assist librarians when supporting disciplinary evidence syntheses:

- Participate in general evidence synthesis coursework offered through regional and national institutes (e.g., Evidence Synthesis Institute Canada https://www.carl-abrc.ca/, Evidence Synthesis Institute https://www.lib.umn.edu/about/evidence-synthesis-institute).
- Participate in discipline-specific evidence synthesis workshops (e.g., Collaboration for Environmental Evidence (CEE) https://environmentalevidence.org/training-2/).
- Get directly involved with an evidence synthesis research project in your discipline of interest. Gaining hands-on experience and working with a team of researchers is an opportunity to better appreciate the nuances of this research methodology.
- Connect with disciplinary research colleagues to explore the relevance of this study's results to your institutional research landscape.

- Identify examples of well-crafted and methodologically sound evidence synthesis articles that incorporate disciplinary reporting standards.
- Study and promote the applicability of established and emerging disciplinary conducting and reporting standards cited in this study - there are several.
- Actively recruit faculty and their research teams to participate in library evidence synthesis workshops, recognizing that researchers outside of medicine and applied health science faculties may be new to this process and value specialised learning opportunities.
- Tailor conversations, instruction, guides, workshops, and web-based resources to clearly demonstrate their relevance to disciplinary evidence synthesis researchers and/or all evidence synthesis researchers.
- Insist that researchers that avail themselves of librarians' expertise acknowledge their value in teaching, published papers, and conference presentations.
- Most importantly, support researchers' capacity to critically evaluate the quality of their work at every stage of the research process.

Throughout this journey, co-investigators welcomed the experience that colleagues shared on how they support evidence synthesis research and researchers. Two librarian colleagues shared their insights,

> Jane Schmidt, Subject Liaison Librarian at Toronto Metropolitan University Libraries' Subject Liaison Librarian commented, "The advice that I always offer is to build from the good work done by the folks in the Cochrane Collaboration and JBI. While it may be clinical in its foundations, the approaches are translatable to different disciplinary contexts. Same approach, different information sources. The search conventions will always differ from database to database, but that's fine. It's been my observation that when I encounter articles that intend to define [evidence synthesis] methodology unique to a particular discipline, a lot of nuance is lost and the strength of the [evidence synthesis] itself is weakened. This has a snowball effect where those articles are then cited, and subsequent [evidence synthesis] gets less and less rigorous... Ultimately, I think we need to chill a little bit when it comes to evidence synthesis that is not being used in life-or-death situations... the horse has already left the barn in terms of not-great articles being published, cited, replicated, etc. Hence, my approach to want to guide folks to the landmark/seminal works.... Adapt it to your discipline, look at how other reviews that have been published were conducted, what are the requirements from the journals they hope to publish in, etc."
>
> personal correspondence, Feb. 4, 2026.
>
> Heather MacDonald, Carleton University MacOdrum Library's HS-STEM and Research Services Librarian commented, "When I teach [knowledge synthesis] to a broad audience, I emphasize the idea of transparency in research, particularly making all decisions clear... Reviews names have been well defined in medicine/health but do not necessarily translate into other domains so understanding the goal of the review is key. If the audience is mixed, I try to give examples in health (easy because there are so many) plus another in a different discipline. My preference is to go into a class or meet with a research team because I can contextualize the content to their

> specific discipline. I did training for my colleagues and had a slate of examples from across several disciplines to help them learn about [knowledge synthesis]. Finding these examples can take time but I found it helpful because now I have those examples at my fingertips to explain when questions come up in a mixed audience."
>
> personal correspondence, Nov. 29, 2025.

Evidence synthesis methodologies in the biological and natural sciences (e.g., systematic reviews) are designed to inform governmental decision-making and policy development. However, as these research designs remain relatively novel within these disciplines, evidence synthesis entails several important conceptual and practical challenges. As one study participant observed, evidence synthesis research "...varies greatly by design, research area, and the purpose of each study." Librarians supporting researchers and their teams are obliged to engage with a diverse array of research questions, designs, fields of study, and an assortment of disciplinary challenges.

A noteworthy study observation is that survey participants are fairly confident in their abilities to perform evidence synthesis research. Yet 42.1% of sample articles did not identify the use of any evidence synthesis conducting or reporting standards. Librarians as research team members can help navigate decision making to identify the most appropriate standard to help ensure methodological soundness and quality reporting. Ghezzi-Kopel et al. (2021) eloquently commented, "As pressure rises for researchers to produce evidence syntheses to inform practice and policymaking in fields that do not have established guidelines, librarian collaboration must become the norm. This will solidify a commitment to presentation of comprehensive, reproducible results and a reduction of research waste across multidisciplinary fields of study" (p.84).

Research teams conducting this work are encouraged to seek out guidance and support from librarians that are knowledgeable about evidence synthesis methodologies, workflows, and quality assessment.

Notes

The authors declare no competing financial interest. All co-authors have given approval to the final version of the manuscript. This paper received ethics clearance from the Brock University Social Science Research Ethics Board file 22-118 - GORDON.

Limitations

Focusing the sample of evidence synthesis articles in the biological and natural sciences on systematic reviews specifically may not have accurately represented the full range and number of evidence synthesis research projects in the disciplines. Bias may have been introduced by Web of Science search strategy logic, use of database filters to refine results, and the selection of survey articles by ranked relevance. Database search results are sensitive to indexing practices, logic, biases of language (i.e., English), dates of publication (i.e., 2024 and 2025), and subject filters (e.g., Research Area) may have limited sample results. The use of a qualitative content analysis methodology to discern findings and observations is susceptible to researcher subjectivity, interpretive, and/or confirmation bias.

Co-investigators original study design included follow-up focus group sessions with groups of survey participants. These sessions and resulting discussions could have generated rich conversations and further data to explore the salient issues that continue to frame evidence synthesis research designs in the

biological and natural sciences. However, due to logistical issues and the time required to offer these sessions, aggregate transcribed data, and analyze findings, co-investigators replaced focus group sessions with individual email interviews to meet a publication deadline. Future investigations could include a study design that includes focus group sessions of biological and natural sciences' evidence synthesis researchers to further explore in depth a wide range of issues including research design, use of reporting standards, assessment techniques, and disciplinary nuances that continue to challenge evidence synthesis research.

Acknowledgments

Co-investigators are thankful to evidence synthesis researchers that participated in this study. We appreciate the encouragement and guidance of librarians that provide excellent service as part of evidence synthesis support teams within many diverse academic communities. An additional acknowledgement to select members of Carleton University's Canadian Centre for Evidence-Based Conservation and Environmental Management (CEBCEM) for their efforts to build support for evidence-based decision making and policy development through training and awareness. We acknowledge the service of Taylor & Francis *Science & Technology Libraries* Editor-in-Chief John J. Meier, Associate Editors, Board members Elizabeth Sterner, Mary C. Schlembach, and colleagues. A special heartful thanks to family and friends for their endless support though this journey.

REFERENCES

Adams, W. M. (2016). Do you speak lion? *Science, 353*(6302), 867-868. https://doi.org/10.1126/science.aaf8056

Ades, A. E., Caldwell, D. M., Reken, S., Welton, N. J., Sutton, A. J., & Dias, S. (2013). Evidence synthesis for decision making 7: A reviewer's checklist. *Medical Decision Making, 33*(5), 679-691. https://doi.org/10.1177/0272989X13485156

Arar, K. H., Özen, H., Polat, G., & Turan, S. (2025). Artificial intelligence, generative artificial intelligence and research integrity: A hybrid systemic review. *Smart Learning Environments, 12*(1), 44. https://doi.org/10.1186/s40561-025-00403-3

Arksey, H., & O'Malley, L. (2005). Scoping studies: Towards a methodological framework. *International Journal of Social Research Methodology, 8*(1), 19-32. https://doi.org/10.1080/1364557032000119616

Aromataris, E., Lockwood, C., Porritt, K., Pilla, B., & Jordan, Z., (Eds.). (2024). *JBI manual for evidence synthesis*. JBI. https://synthesismanual.jbi.global.

Ayambire, R. A., Rytwinski, T., Taylor, J. J., Luizza, M. W., Muir, M. J., Cadet, C., Armitage, D., Bennett, N. J., Brooks, J., Cheng, S. H., Martinez, J., Nagendran, M., Öckerman, S., Rivera, S. N., Savage, A., Wilkie, D. S., Cooke, S. J., & Bennett, J. R. (2024). Challenges in assessing the effects of environmental governance systems on conservation outcomes. *Conservation Biology, 39*(1), e14392. https://doi.org/10.1111/cobi.14392

Belovsky, G. E., Botkin, D. B., Crowl, T. A., Cummins, K. W., Franklin, J. F., Hunter, M. L., Joern, A., Lindenmayer, D. B., MacMahon, J. A., Margules, C. R., & Scott, J. M. (2004). Ten suggestions to strengthen the science of ecology. *BioScience, 54*(4), 345-351. https://doi.org/10.1641/0006-3568(2004)054%5B0345:TSTSTS%5D2.0.CO;2

Berger-Tal, O., Greggor, A. L., Macura, B., Adams, C. A., Blumenthal, A., Bouskila, A., Candolin, U., Doran, C., Fernández-Juricic, E., Gotanda, K. M., Price, C., Putman, B. J., Segoli, M., Snijders, L., Wong, B. B. M., & Blumstein, D. T. (2018). Systematic reviews and maps as tools for applying behavioral ecology to management and policy. *Behavioral Ecology, 30*(1), 1-8. https://doi.org/10.1093/beheco/ary130

Berger-Tal, O., Wong, B. B. M., Adams, C. A., Blumstein, D. T., Candolin, U., Gibson, M. J., Greggor, A. L., Lagisz, M., Macura, B., Price, C. J., Putman, B. J., Snijders, L., & Nakagawa, S. (2024). Leveraging AI to improve evidence synthesis in conservation. *Trends in Ecology & Evolution, 39*(6), 548–557. https://doi.org/10.1016/j.tree.2024.04.007

Boden, C., Bolton, S., & Gerrard, A. (2025). Health sciences and beyond: An investigation into Canadian librarian participation in systematic reviews across disciplines. *College & Research Libraries, 86*(1), 79-100. https://doi.org/10.5860/crl.86.1.79

Boice, J. (2019). An exploration of systematic review publication trends in conservation biology journals. *Issues in Science & Technology Librarianship, 91*, 1-11. https://doi.org/10.29173/istl2

Bolaños, F., Salatino, A., Osborne, F., & Motta, E. (2024). Artificial intelligence for literature reviews: Opportunities and challenges. *Artificial Intelligence Review, 57*(10), 259. https://doi.org/10.1007/s10462-024-10902-3

Bonato, S. (2018). *Searching the grey literature: A handbook for searching reports, working papers, and other unpublished research*. Rowman & Littlefield.

Borges Migliavaca, C., Stein, C., Colpani, V., Barker, T. H., Munn, Z., Falavigna, M., & Prevalence Estimates Reviews – Systematic Review Methodology Group (PERSyst). (2020). How are systematic reviews of prevalence conducted? A methodological study. *BMC Medical Research Methodology, 20(*1), 96. https://doi.org/10.1186/s12874-020-00975-3

Braun, C., Grummich, K., Möhler, R., Schaefer, C., & Pieper, D. (2025). Wir brauchen weniger, dafür bessere systematische Reviews! Ein Aufruf zum Handeln [We need fewer but better systematic reviews! A call for action]. *Zeitschrift fur Evidenz, Fortbildung und Qualitat im Gesundheitswesen,* 198-199, 1-8. https://doi.org/10.1016/j.zefq.2025.10.008

Cherry, M. G., Boland, A., & Dickson, R. (2024). *Doing a systematic review: A student's guide* (3rd ed.). Sage.

Collins, A. M., Coughlin, D., & Randall, N. (2019). Engaging environmental policy-makers with systematic reviews: Challenges, solutions and lessons learned. *Environmental Evidence, 8*(1), 2. https://doi.org/10.1186/s13750-018-0144-0

Cook, C. N., Nichols, S. J., Webb, J. A., Fuller, R. A., & Richards, R. M. (2017). Simplifying the selection of evidence synthesis methods to inform environmental decisions: A guide for decision makers and scientists. *Biological Conservation, 213*, 135–145. https://doi.org/10.1016/j.biocon.2017.07.004

Cooke, S. J., Birnie-Gauvin, K., Lennox, R. J., Taylor, J. J., Rytwinski, T., Rummer, J. L., Franklin, C. E., Bennett, J. R., & Haddaway, N. R. (2017). How experimental biology and ecology can support evidence-based decision-making in conservation: Avoiding pitfalls and enabling application. *Conservation Physiology, 5*(1). https://doi.org/10.1093/conphys/cox043

Cooke, S. J., Cook, C. N., Nguyen, V. M., Walsh, J. C., Young, N., Cvitanovic, C., Grainger, M. J., Randall, N. P., Muir, M., Kadykalo, A. N., Monk, K. A., & Pullin, A. S. (2023). Environmental evidence in action: On the science and practice of evidence synthesis and evidence-based decision-making. *Environmental Evidence, 12*(1), 10. https://doi.org/10.1186/s13750-023-00302-5

Cooke, S. J., Rytwinski, T., Taylor, J. J., Nyboer, E. A., Nguyen, V. M., Bennett, J. R., Young, N., Aitken, S., Auld, G., Lane, J.-F., Prior, K. A., Smokorowski, K. E., Smith, P. A., Jacob, A. L., Browne, D. R., Blais, J. M., Kerr, J. T., Ormeci, B., Alexander, S. M., … Smol, J. P. (2020). On "success" in applied environmental research—What is it, how can it be achieved, and how does one know when it has been achieved? *Environmental Reviews, 28*(4), 357-372. https://doi.org/10.1139/er-2020-0045

Covington, E. (2025). *Evidence synthesis guide 2: How to decide which evidence synthesis type is right for you*. Sage. https://doi.org/10.4135/9781036222727

Coxon, C. H., Longstaff, C., & Burns, C. (2019). Applying the science of measurement to biology: Why bother? *PLOS Biology, 17*(6), e3000338. https://doi.org/10.1371/journal.pbio.3000338

Dance, A. (2026). Why every scientist needs a librarian. *Nature, 650*(8103), 1063-1065. https://doi.org/10.1038/d41586-026-00568-y

De Cassai, A., Dost, B., Tulgar, S., & Boscolo, A. (2025). Methodological standards for conducting high-quality systematic reviews. *Biology, 14*(8), 973. https://doi.org/10.3390/biology14080973

Dekkers, R., Carey, L., & Langhorne, P. (2022). Making literature reviews work: A multidisciplinary guide to systematic approaches. Springer. https://doi.org/10.1007/978-3-030-90025-0

Dermondy, K., Farnum, C., Jakubek, D., Kovacaj, F., Petropoulos, J-A., Schmidt, J., & Steinberg, R. (2022). *Advanced research skills: Conducting literature and systematic reviews* (3rd ed.). Toronto Metropolitan University Pressbooks. https://pressbooks.library.torontomu.ca/graduatereviews3/

Downey, H., Amano, T., Cadotte, M., Cook, C. N., Cooke, S. J., Haddaway, N. R., Jones, J. P. G., Littlewood, N., Walsh, J. C., Abrahams, M. I., Adum, G., Akasaka, M., Alves, J. A., Antwis, R. E., Arellano, E. C., Axmacher, J., Barclay, H., Batty, L., Benítez-López, A., ... Sutherland, W. J. (2021). Training future generations to deliver evidence-based conservation and ecosystem management. *Ecological Solutions and Evidence, 2*(1), e12032. https://doi.org/10.1002/2688-8319.12032

Downey, H., Bretagnolle, V., Brick, C., Bulman, C. R., Cooke, S. J., Dean, M., Edmonds, B., Frick, W. F., Friedman, K., McNicol, C., Nichols, C., Herbert, S., O'Brien, D., Ockendon, N., Petrovan, S., Stroud, D., White, T. B., Worthington, T. A., & Sutherland, W. J. (2022). Principles for the production of evidence-based guidance for conservation actions. *Conservation Science and Practice, 4*(5), e12663. https://doi.org/10.1111/csp2.12663

Dwivedi, A. K. (2026). Step-by-step guide and checklists for selecting and conducting an evidence synthesis study using a framework for approaches and methods in evidence synthesis (Frames). *PeerJ,* 14, e20897. https://doi.org/10.7717/peerj.20897

Eastaugh, C. H., Still, M., Beyer, F. R., Wallace, S. A., & O'Keefe, H. (2025). Exploring the role of artificial intelligence in evidence synthesis: Insights from the core information retrieval forum 2025. *Cochrane Evidence Synthesis and Methods, 3*(5), e70049. https://doi.org/10.1002/cesm.70049

Elliott-Graves, A. (2025). Reevaluating heterogeneity in evidence synthesis. *Philosophy of Science*, 1-20. https://doi.org/10.1017/psa.2025.10176

Fazey, I., Salisbury, J. G., Lindenmayer, D. B., Maindonald, J., & Douglas, R. (2004). Can methods applied in medicine be used to summarize and disseminate conservation research? *Environmental Conservation, 31*(3), 190-198. https://doi.org/10.1017/S0376892904001560

Flemyng, E., Norl-Storr, A., Macura, B., Gartlehner, G., Thomas, J., Meerpohl, J. J., Jordan, Z., Minx, J., Eisele-Metzger, A., Hamel, C., Jemioło, P., Porritt, K., & Grainger, M. (2025). Position statement on artificial intelligence (Ai) use in evidence synthesis across Cochrane, the Campbell Collaboration, JBI and the Collaboration for Environmental Evidence 2025. *Cochrane Database Systematic Reviews.* https://doi.org/10.1002/14651858.ED000178

Foo, Y. Z., O'Dea, R. E., Koricheva, J., Nakagawa, S., & Lagisz, M. (2021). A practical guide to question formation, systematic searching and study screening for literature reviews in ecology and evolution. *Methods in Ecology and Evolution, 12*(9), 1705-1720. https://doi.org/10.1111/2041-210X.13654

Foster, M. J., & Jewell, S. T. (Eds.). (2022). *Piecing together systematic reviews and other evidence syntheses*. Rowman & Littlefield.

Fraser, H., Parker, T., Nakagawa, S., Barnett, A., & Fidler, F. (2018). Questionable research practices in ecology and evolution. *PLOS ONE, 13*(7), e0200303. https://doi.org/10.1371/journal.pone.0200303

Georgieva, E., & Georgiev, T. (2025). How artificial intelligence can transform services in research libraries. In C. Kahraman, S. Cebi, B. Oztaysi, S. Cevik Onar, C. Tolga, I. Ucal Sari, & I. Otay (Eds.), *Intelligent and Fuzzy Systems* (Vol. 1530, pp. 703-716). Springer Nature Switzerland. https://doi.org/10.1007/978-3-031-98565-2_76

Ghezzi-Kopel, K., Ault, J., Chimwaza, G., Diekmann, F., Eldermire, E., Gathoni, N., Kelly, J., Kinengyere, A. A., Kocher, M., Lwoga, E. T., Page, J., Young, S., & Porciello, J. (2021). Making the case for librarian expertise to support evidence synthesis for the sustainable development goals. *Research Synthesis Methods, 13*(1), 77–87. https://doi.org/10.1002/jrsm.1528

Grames, E. M., & Elphick, C. S. (2020). Use of study design principles would increase the reproducibility of reviews in conservation biology. *Biological Conservation, 241*, 108385. https://doi.org/10.1016/j.biocon.2019.108385

Gray, R. (2020). Why do all systematic reviews have fifteen studies? *Nurse Author & Editor, 30*(4), 27-29. https://doi.org/10.1111/nae2.8

Gusenbauer, M., & Haddaway, N. R. (2020). Which academic search systems are suitable for systematic reviews or meta-analyses? Evaluating retrieval qualities of Google Scholar, PubMed, and 26 other resources. R*esearch Synthesis Methods, 11*(2), 181-217. https://doi.org/10.1002/jrsm.1378

Haddaway, N. R. (2015a), A call for better reporting of conservation research data for use in meta-analyses. *Conservation Biology, 29*: 1242-1245. https://doi.org/10.1111/cobi.12449

Haddaway, N. R. (2015b). The use of web-scraping software in searching for grey literature. *The Grey Journal (TGJ), 11*(3), 186-90.

Haddaway, N. R., & Bayliss, H. R. (2015). Shades of grey: Two forms of grey literature important for reviews in conservation. *Biological Conservation, 191*, 827-829. https://doi.org/10.1916/j.biocon.2015.08.018

Haddaway, N. R., Bernes, C., Jonsson, B.-G., & Hedlund, K. (2016). The benefits of systematic mapping to evidence-based environmental management. *Ambio, 45*(5), 613-620. https://doi.org/10.1007/s13280-016-0773-x

Haddaway, N. R., Macura, B., Whaley, P., & Pullin, A. S. (2018). ROSES RepOrting standards for Systematic Evidence Syntheses: Pro forma, flow-diagram and descriptive summary of the plan and

conduct of environmental systematic reviews and systematic maps. *Environmental Evidence, 7*(1), 7. https://doi.org/10.1186/s13750-018-0121-7

Haddaway, N. R., & Pullin, A. S. (2014). The policy role of systematic reviews: Past, present and future. *Springer Science Reviews, 2*(1-2), 179-183. https://doi.org/10.1007/s40362-014-0023-1

Haddaway, N. R., & Westgate, M. J. (2018). Predicting the time needed for environmental systematic reviews and systematic maps. *Conservation Biology, 33*(2), 434-443. https://doi.org/10.1111/cobi.13231

Haddaway, N. R., Woodcock, P., Macura, B., & Collins, A. (2015). Making literature reviews more reliable through application of lessons from systematic reviews. *Conservation Biology, 29*(6), 1596-1605. https://doi.org/10.1111/cobi.12541

Higgins, J. P. T., López-López, J. A., Becker, B. J., Davies, S. R., Dawson, S., Grimshaw, J. M., McGuinness, L. A., Moore, T. H. M., Rehfuess, E. A., Thomas, J., & Caldwell, D. M. (2019). Synthesising quantitative evidence in systematic reviews of complex health interventions. *BMJ Global Health, 4*(Suppl 1), e000858. https://doi.org/10.1136/bmjgh-2018-000858

Higgins, J. P. T., Thomas, J., Chandler, J., Cumpston, M., Li, T., Page, M., & Welch, V. (2024). *Cochrane handbook for systematic reviews of interventions.* https://www.cochrane.org/handbook

Higglefsen, M. L., Kirtley, S., Waffenschmidt, S., Ayala, A. P., Moher, D., Page, M. J., Koffel, J. B., PRISMA-S Group, Blunt, H., Brigham, T., Chang, S., Clark, J., Conway, A., Couban, R., De Kock, S., Farrah, K., Fehrmann, P., Foster, M., Fowler, S. A., … Young, S. (2021). PRISMA-S: An extension to the PRISMA statement for reporting literature searches in systematic reviews. *Systematic Reviews, 10*(1), 39. https://doi.org/10.1186/s13643-020-01542-z

Ioannidis, J. P. A. (2023). Systematic reviews for basic scientists: A different beast. *Physiological Reviews, 103*(1), 1-5. https://doi.org/10.1152/physrev.00028.2022

James, K. L., Randall, N. P., & Haddaway, N. R. (2016). A methodology for systematic mapping in environmental sciences. *Environmental Evidence, 5*(1), 7. https://doi.org/10.1186/s13750-016-0059-6

Kadykalo, A. N., Buxton, R. T., Morrison, P., Anderson, C. M., Bickerton, H., Francis, C. M., Smith, A. C., & Fahrig, L. (2021). Bridging research and practice in conservation. *Conservation Biology, 35*(6), 1725–1737. https://doi.org/10.1111/cobi.13732

Kallaher, A., Eldermire, E. R. B., Fournier, C. T., Ghezzi-Kopel, K., Johnson, K. A., Morris-Knower, J., Scinto-Madonich, S., & Young, S. (2020). Library systematic review service supports evidence-based practice outside of medicine. *The Journal of Academic Librarianship, 46*(6), 102222. https://doi.org/10.1016/j.acalib.2020.102222

Kolaski, K., Logan, L. R., & Ioannidis, J. P. A. (2023). Guidance to best tools and practices for systematic reviews. *JBI Evidence Synthesis, 21*(9), 1699-1731. https://doi.org/10.11124/JBIES-23-00139

Konno, K., Livoreil, B., & Pullin, A. S. (2021). *Collaboration for environmental evidence (CEE) critical appraisal tool.* https://environmentalevidence.org/cee-critical-appraisal-tool

Kuckartz, U., & Rädiker, S. (2023). *Qualitative content analysis: Methods, practice and software* (2nd ed.). Sage.

Kugley, S., & Epstein, R. (2018). Gathering evidence from grey literature and unpublished data. In P. Levay & J. Craven (Eds.), *Systematic Searching* (pp. 95-124). Facet.

Laynor, G., & Roth, S., (2022). Librarians as research partners for developing evidence synthesis protocols, In C. Forbes (Ed.), *Academic Libraries and Collaborative Research Services* (pp. 81-104). Rowman & Littlefield.

Lê, M.-L., Winkler, J., & Neilson, C. (2024). Training needs and preferences for librarians supporting systematic reviews in the sciences, humanities, and social sciences. *College & Research Libraries, 85*(7). https://doi.org/10.5860/crl.85.7.978

Linares-Espinós, E., Hernández, V., Domínguez-Escrig, J. L., Fernández-Pello, S., Hevia, V., Mayor, J., Padilla-Fernández, B., & Ribal, M. J. (2018). Methodology of a systematic review. *Actas Urológicas Españolas (English Ed.), 42*(8), 499-506. https://doi.org/10.1016/j.acuroe.2018.07.002

Livoreil, B., Glanville, J., Haddaway, N. R., Bayliss, H., Bethel, A., De Lachapelle, F. F., Robalino, S., Savilaakso, S., Zhou, W., Petrokofsky, G., & Frampton, G. (2017). Systematic searching for environmental evidence using multiple tools and sources. *Environmental Evidence, 6*(1), 23. https://doi.org/10.1186/s13750-017-0099-6

Madliger, C. L., Love, O. P., Nguyen, V. M., Haddaway, N. R., & Cooke, S. J. (2021). Researcher perspectives on challenges and opportunities in conservation physiology revealed from an online survey. *Conservation Physiology, 9*(1), coab030. https://doi.org/10.1093/conphys/coab030

Martin, P. A., Christie, A. P., Shackelford, G. E., Hood, A. S. C., Wang, S., Li, B., Morgan, W., Lee, M., Aldridge, D. C., & Sutherland, W. J. (2023). Flexible synthesis can deliver more tailored and timely evidence for research and policy. *Proceedings of the National Academy of Sciences, 120*(25), e2221911120. https://doi.org/10.1073/pnas.2221911120

McDonald, J. H. (2014). Confounding Variables, In, *Handbook of biological statistics* (3rd ed.). Sparky House. https://www.biostathandbook.com/confounding.html

McIntosh, E. J., Pressey, R. L., Lloyd, S., Smith, R. J., & Grenyer, R. (2017). The impact of systematic conservation planning. *Annual Review of Environment and Resources, 42*(1), 677-697. https://doi.org/10.1146/annurev-environ-102016-060902

Mishra, V., & Mishra, M. P. (2023). PRISMA for review of management literature – method, merits, and limitations – an academic review. In S. Rana, J. Singh, & S. Kathuria (Eds.), Review of Management L*iterature* (pp. 125-136). Emerald. https://doi.org/10.1108/S2754-586520230000002007

Moher, D., Liberati, A., Tetzlaff, J., Altman, D. G., & The PRISMA Group. (2009). Preferred reporting items for systematic reviews and meta-analyses: The PRISMA statement. *PLoS Medicine, 6*(7), e1000097. https://doi.org/10.1371/journal.pmed.1000097

Møller, A., & Jennions, M. D. (2002). How much variance can be explained by ecologists and evolutionary biologists? *Oecologia, 132*(4), 492-500. https://doi.org/10.1007/s00442-002-0952-2

Mupepele, A., Walsh, J. C., Sutherland, W. J., & Dormann, C. F. (2016). An evidence assessment tool for ecosystem services and conservation studies. *Ecological Applications, 26*(5), 1295-1301. https://doi.org/10.1890/15-0595

Nakagawa, S., & Lagisz, M. (2019). How good does our map of knowledge have to be? A comment on Berger-Tal et al. *Behavioral Ecology, 30*(1), 13-14. https://doi.org/10.1093/beheco/ary137

Nakagawa, S., Yang, Y., Macartney, E. L., Spake, R., & Lagisz, M. (2023). Quantitative evidence synthesis: A practical guide on meta-analysis, meta-regression, and publication bias tests for environmental sciences. *Environmental Evidence, 12*(1), 8. https://doi.org/10.1186/s13750-023-00301-6

Nowell, L., Paolucci, A., Dhingra, S., Jacobsen, M., Lorenzetti, D. L., Lorenzetti, L., & Oddone-Paolucci, E. (2022). Interdisciplinary mixed methods systematic reviews: Reflections on methodological best practices, theoretical considerations, and practical implications across disciplines. *Social Sciences & Humanities Open, 6*(1), 100295. https://doi.org/10.1016/j.ssaho.2022.100295

Noyes, J., & Harden, A. (2024). *Cochrane-Campbell handbook for qualitative evidence synthesis.* Cochrane, Campbell Collaboration. https://www.cochrane.org/authors/handbooks-and-manuals/cochrane-campbell-handbook-qualitative-evidence-synthesis

Nussbaumer-Streit, B., Booth, A., Garritty, C., Hamel, C., Munn, Z., Tricco, A. C., & Pollock, D. (2025). Overview of evidence synthesis types and modes. J*ournal of Clinical Epidemiology, 187,* 111970. https://doi.org/10.1016/j.jclinepi.2025.111970

Nyboer, E. A., Kadykalo, A. N., Young, N., Nguyen, V. M., Rytwinski, T., Lane, J.-F., Bennett, J. R., Harron, N., Aitken, S. M., Auld, G., Browne, D., Jacob, A. L., Prior, K., Smith, P. A., Smokorowski, K. E., Alexander, S., & Cooke, S. J. (2025). What is 'good evidence' for environmental decision making? Insights from professionals working at the science-policy interface. *Environmental Science & Policy, 171,* 104176. https://doi.org/10.1016/j.envsci.2025.104176

Nyboer, E. A., Nguyen, V. M., Young, N., Rytwinski, T., Taylor, J. J., Lane, J. F., Bennett, J. R., Harron, N., Aitken, S. M., Auld, G., Browne, D., Jacob, A. I., Prior, K., Smith, P. A., Smokorowski, K. E., Alexander, S., & Cooke, S. J. (2021). Supporting actionable science for environmental policy: Advice for funding agencies from decision makers. *Frontiers in Conservation Science, 2*, 693129. https://doi.org/10.3389/fcosc.2021.693129

O'Dea, R. E., Lagisz, M., Jennions, M. D., Koricheva, J., Noble, D. W. A., Parker, T. H., Gurevitch, J., Page, M. J., Stewart, G., Moher, D., & Nakagawa, S. (2021). Preferred reporting items for systematic reviews and meta-analyses in ecology and evolutionary biology: A PRISMA extension. *Biological Reviews, 96*(5), 1695–1722. https://doi.org/10.1111/brv.12721

O'Leary, B. C., Kvist, K., Bayliss, H. R., Derroire, G., Healey, J. R., Hughes, K., Kleinschroth, F., Sciberras, M., Woodcock, P., & Pullin, A. S. (2016). The reliability of evidence review methodology in environmental science and conservation. *Environmental Science & Policy, 64,* 75-82. https://doi.org/10.1016/j.envsci.2016.06.012

Page, M. J., McKenzie, J. E., Bossuyt, P. M., Boutron, I., Hoffmann, T. C., Mulrow, C. D., Shamseer, L., Tetzlaff, J. M., Akl, E. A., Brennan, S. E., Chou, R., Glanville, J., Grimshaw, J. M., Hróbjartsson, A.,

Lalu, M. M., Li, T., Loder, E. W., Mayo-Wilson, E., McDonald, S., … Moher, D. (2021a). The PRISMA 2020 statement: An updated guideline for reporting systematic reviews. *BMJ, n71*. https://doi.org/10.1136/bmj.n71

Page, M. J., McKenzie, J. E., Bossuyt, P. M., Boutron, I., Hoffmann, T. C., Mulrow, C. D., Shamseer, L., Tetzlaff, J. M., & Moher, D. (2021b). Updating guidance for reporting systematic reviews: Development of the PRISMA 2020 statement. *Journal of Clinical Epidemiology, 134*, 103-112. https://doi.org/10.1016/j.jclinepi.2021.02.003

Park, S. G. (2025). Ai and systematic reviews: Can AI tools replace librarians in the systematic search process? *Science & Technology Libraries*, 1-22. https://doi.org/10.1080/0194262X.2025.2521519

Parker, T. H., Forstmeier, W., Koricheva, J., Fidler, F., Hadfield, J. D., Chee, Y. E., Kelly, C. D., Gurevitch, J., & Nakagawa, S. (2016). Transparency in Ecology and Evolution: Real Problems, Real Solutions. *Trends in Ecology & Evolution, 31*(9), 711-719. https://doi.org/10.1016/j.tree.2016.07.002

Pasquier, T., Lau, M. K., Trisovic, A., Boose, E. R., Couturier, B., Crosas, M., Ellison, A. M., Gibson, V., Jones, C. R., & Seltzer, M. (2017). If these data could talk. *Scientific Data, 4*(1), 170114. https://doi.org/10.1038/sdata.2017.114

Peters, M. D. J., Marnie, C., Colquhoun, H., Garritty, C. M., Hempel, S., Horsley, T., Langlois, E. V., Lillie, E., O'Brien, K. K., Tunçalp, Özge, Wilson, M. G., Zarin, W., & Tricco, A. C. (2021). Scoping reviews: Reinforcing and advancing the methodology and application. *Systematic Reviews, 10*(1), 263. https://doi.org/10.1186/s13643-021-01821-3

Pullin, A. S., Cheng, S. H., Cooke, S. J., Haddaway, N. R., Macura, B., McKinnon, M. C., & Taylor, J. J. (2020). Informing conservation decisions through evidence synthesis and communication. In W. J. Sutherland, P. N.M. Brotherton, Z. G. Davies, N. Ockendon, N. Pettorelli, & J. A. Vickery (Eds.), Conservation research, policy and practice (pp. 114-128). Cambridge. https://doi.org/10.1017/9781108638210

Pullin, A. S., Cheng, S. H., Jackson, J. D., Eales, J., Envall, I., Fada, S. J., Frampton, G. K., Harper, M., Kadykalo, A. N., Kohl, C., Konno, K., Livoreil, B., Ouédraogo, D.-Y., O'Leary, B. C., Pullin, G., Randall, N., Rees, R., Smith, A., Sordello, R., … Woodcock, P. (2022). Standards of conduct and reporting in evidence syntheses that could inform environmental policy and management decisions. *Environmental Evidence, 11*(1), 16. https://doi.org/10.1186/s13750-022-00269-9

Pullin, A. S., Frampton, G., Livoreil, B., & Petrokofsky, G. (2022). *Guidelines and standards for evidence synthesis in environmental management*. https://eprints.soton.ac.uk/477961/

Pullin, A. S., Knight, T. M., Stone, D. A., & Charman, K. (2004). Do conservation managers use scientific evidence to support their decision-making? *Biological Conservation, 119*(2), 245–252. https://doi.org/10.1016/j.biocon.2003.11.007

Pullin, A. S., & Knight, T. M. (2001). Effectiveness in conservation practice: Pointers from medicine and public health. *Conservation Biology 15*: 50-54.

Pullin, A. S., & Knight, T. M. (2009). Doing more good than harm – Building an evidence-base for conservation and environmental management. *Biological Conservation, 142*(5), 931-934. https://doi.org/10.1016/j.biocon.2009.01.010

Pullin, A. S., & Stewart, G. B. (2006). Guidelines for systematic review in conservation and environmental management. *Conservation Biology, 20*(6), 1647-1656. https://doi.org/10.1111/j.1523-1739.2006.00485.x

Rebello, C. M., Asunda, P. A., & Wang, H. H. (2020). Infusing evidence-based reasoning in integrated STEM. In C. C. Johnson, M. J. Mohr-Schroeder, T. J. Moore, T. J., & L. D. English (Eds.), *Handbook of research on STEM education* (pp. 184-195). London: Routledge.

Rethlefsen, M. L., Kirtley, S., Waffenschmidt, S., Ayala, A. P., Moher, D., Page, M. J., Koffel, J. B., & PRISMA-S Group. (2021). PRISMA-S: An extension to the PRISMA statement for reporting literature searches in systematic reviews. *Systematic Reviews 10*, 39 (2021). https://doi.org/10.1186/s13643-020-01542-z

Roberts, P. D., Stewart, G. B., & Pullin, A. S. (2006). Are review articles a reliable source of evidence to support conservation and environmental management? A comparison with medicine. *Biological Conservation, 132*(4), 409-423. https://doi.org/10.1016/j.biocon.2006.04.034

Roche, D. G., O'Dea, R. E., Kerr, K. A., Rytwinski, T., Schuster, R., Nguyen, V. M., Young, N., Bennett, J. R., & Cooke, S. J. (2022). Closing the knowledge-action gap in conservation with open science. *Conservation Biology, 36*(3), e13835. https://doi.org/10.1111/cobi.13835

Romanelli, J. P., Meli, P., Naves, R. P., Alves, M. C., & Rodrigues, R. R. (2021). Reliability of evidence-review methods in restoration ecology. *Conservation Biology, 35*(1), 142-154. https://doi.org/10.1111/cobi.13661

Sabo, A. N., Berger-Tal, O., Blumstein, D. T., Greggor, A. L., & Swaddle, J. P. (2024). Conservation practitioners' and researchers' needs for bridging the knowledge–action gap. *Frontiers in Conservation Science, 5,* 1415127. https://doi.org/10.3389/fcosc.2024.1415127

Scott, M. C., & Vogus, B. (2022). Academic librarians and systematic reviews: trends and services. *Public Services Quarterly, 18*(3), 202-208. https://doi.org/10.1080/15228959.2022.2086664

Segan, D. B., Bottrill, M. C., Baxter, P. W. J., & Possingham, H. P. (2011). Using conservation evidence to guide management. *Conservation Biology, 25*(1), 200-202. https://doi.org/10.1111/j.1523-1739.2010.01582.x

Senior, A. M., Grueber, C. E., Kamiya, T., Lagisz, M., O'Dwyer, K., Santos, E. S. A., & Nakagawa, S. (2016). Heterogeneity in ecological and evolutionary meta-analyses: Its magnitude and implications. E*cology, 97*(12), 3293-3299. https://doi.org/10.1002/ecy.1591

Siemens, W., Von Elm, E., Binder, H., Böhringer, D., Eisele-Metzger, A., Gartlehner, G., Hanegraaf, P., Metzendorf, M.-I., Mosselman, J.-J., Nowak, A., Qureshi, R., Thomas, J., Waffenschmidt, S., Labonté, V., & Meerpohl, J. J. (2025). Opportunities, challenges and risks of using artificial intelligence for evidence synthesis. *BMJ Evidence-Based Medicine, 30*(6), 381-384. https://doi.org/10.1136/bmjebm-2024-113320

Slebodnik, M. (2022). Evidence Synthesis: Coming soon to a library near you? *Portal: Libraries & the Academy, 22*(2), 273-280. https://doi.org/10.1353/pla.2022.0016

Smaldino, P. E., & McElreath, R. (2016). The natural selection of bad science. *Royal Society Open Science, 3*(9), 160384. https://doi.org/10.1098/rsos.160384

Sousa, M. S. A., Peiris, S., Figueiró, M. F., Haby, M. M., Baraldi, A. C., Reveiz, L., & Souza, J. P. (2026). The landscape of artificial intelligence tools and platforms for evidence synthesis: A scoping review. *Systematic Reviews*. https://doi.org/10.1186/s13643-025-02842-y

Stanhope, J., & Weinstein, P. (2023). Critical appraisal in ecology: What tools are available, and what is being used in systematic reviews? *Research Synthesis Methods, 14*(3), 342-356. https://doi.org/10.1002/jrsm.1609

Stevens, M., & Norris, D. R. (2022). A mixed methodology for evaluating use of evidence in conservation planning. *Conservation Biology, 36*(4), e13876. https://doi.org/10.1111/cobi.13876

Sutherland, W. J. (Ed.). (2022). *Transforming conservation: A practical guide to evidence and decision making*. Open Book Publishers. https://www.openbookpublishers.com/books/10.11647/obp.0321

Sutherland, W. J., Pullin, A. S., Dolman, P. M., & Knight, T. M. (2004). The need for evidence-based conservation. *Trends in Ecology & Evolution, 19*(6), 305-308. https://doi.org/10.1016/j.tree.2004.03.018

Sutton, A., Clowes, M., Preston, L., & Booth, A. (2019). Meeting the review family: Exploring review types and associated information retrieval requirements. *Health Information & Libraries Journal, 36*(3), 202-222. https://doi.org/10.1111/hir.12276

The value of evidence synthesis. (2021). *Nature Human Behaviour, 5*(5), 539–539. https://doi.org/10.1038/s41562-021-01131-7

Thomas-Walters, L., Nyboer, E. A., Taylor, J. J., Rytwinski, T., Lane, J. F., Young, N., Bennett, J. R., Nguyen, V. M., Harron, N., Aitken, S. M., Auld, G., Browne, D., Jacob, A. L., Prior, K., Smith, P. A., Smokorowski, K. E., Alexander, S. M., & Cooke, S. J. (2021). An optimistic outlook on the use of evidence syntheses to inform environmental decision-making. *Conservation Science and Practice, 3*(6), e426. https://doi.org/10.1111/csp2.426

Toomey, A. H., Knight, A. T., & Barlow, J. (2017). Navigating the Space between Research and Implementation in Conservation. *Conservation Letters, 10*(5), 619-625. https://doi.org/10.1111/conl.12315

Tricco, A. C., Lillie, E., Zarin, W., O'Brien, K. K., Colquhoun, H., Levac, D., Moher, D., Peters, M. D. J., Horsley, T., Weeks, L., Hempel, S., Akl, E. A., Chang, C., McGowan, J., Stewart, L., Hartling, L., Aldcroft, A., Wilson, M. G., Garritty, C., … Straus, S. E. (2018). Prisma extension for scoping reviews (Prisma-scr): Checklist and explanation. *Annals of Internal Medicine*, *169*(7), 467-473. https://doi.org/10.7326/M18-0850

UNEP-WCMC. (2023). *Connecting nature in a fragmented world: The importance of conserving ecological connectivity in the next decade. Environment Programme World Conservation Monitoring*

Centre (UNEP-WCMC). https://www.unep-wcmc.org/en/news/connecting-nature-in-a-fragmented-world-the-importance-of-conserving-ecological-connectivity-in-the-next-decade

Westgate, M. J., & Lindenmayer, D. B. (2017). The difficulties of systematic reviews. *Conservation Biology, 31*(5), 1002-1007. https://doi.org/10.1111/cobi.12890

Walsh, J. C., Dicks, L. V., & Sutherland, W. J. (2015). The effect of scientific evidence on conservation practitioners' management decisions. *Conservation Biology, 29*(1), 88–98. https://doi.org/10.1111/cobi.12370

Woodcock, P., Pullin, A. S., & Kaiser, M. J. (2014). Evaluating and improving the reliability of evidence syntheses in conservation and environmental science: A methodology. *Biological Conservation, 176*, 54-62. https://doi.org/10.1016/j.biocon.2014.04.020

Wyborn, C., Louder, E., Harrison, J., Montambault, J., Montana, J., Ryan, M., Bednarek, A., Nesshöver, C., Pullin, A., Reed, M., Dellecker, E., Kramer, J., Boyd, J., Dellecker, A., & Hutton, J. (2018). Understanding the impacts of research synthesis. *Environmental Science & Policy, 86*, 72–84. https://doi.org/10.1016/j.envsci.2018.04.013

Appendix A

Web of Science Search Strategy

1. Title (systematic* or rapid* or “evidence synthes?s* or scoping*) near/2 review*
2. Topic (conservat* or biolog* or ecolog* or natural*)
3. 1 and 2
4. Publication Years: 2024-2025
5. Document Types: Article or Review Article
6. Languages: English
7. Web of Science Research Areas: Environmental Sciences Ecology or Rehabilitation or Plant Sciences or Cell Biology or Geography or Water Resources or Evolutionary Biology or Mycology or Biochemistry Molecular Biology
8. 4 and 5 and 6 and 7
9. 3 and 8
10. Capture step 9 first 150 ranked by relevance citations

Clarivate Web of Science Complete databases: Web of Science Core Collection, Biological Abstracts, BIOSIS, BIOSIS Citation Index, BIOSIS Previews, Current Contents Connect, SciELO Citation Index, and Zoological Record.

Appendix B

Qualtrics Survey Instrument

Question 1

With full knowledge and having read the information presented, I agree to participate in this study:

Yes, I agree to participate in this study

No, I do not agree to provide consent nor participate in this study

Question 2

I can best be described as... please select one:

Faculty

Student

Staff

Other, please elaborate _____

Decline to answer

Question 3

On a scale of 1 (not confident at all) to 5 (Extremely confident), how would you rate confidence in your ability to conduct evidence synthesis-based research e.g. systematic reviews?

1 2 3 4 5

Question 4

What training e.g. course(s), seminars, informal learning… informed your understanding of evidence synthesis research practices? Please elaborate, or decline to answer:

_____

Question 5

Listed below are 12 stages of evidence synthesis research. Thinking about your experiences with evidence synthesis in the biological or natural sciences, rate each stage on a scale of 1 (Very easy) to 5 (Very challenging), or not appropriate (NA): Please select one response for each stage, or decline to answer:

Stages of evidence synthesis research

1 2 3 4 5 NA

Developing and registering protocols

Draft your research question(s)

Select databases

Select grey literature sources

Create database search strategies

Citation / export management

Article / citation screening

Data selection

Risk of bias assessment

Quality of data assessment

Synthesize, map or describe results

Discern impact of resulting research

Question 6

What is notable or unique when conducting evidence synthesis research specifically in the biological and natural sciences?

_____

We thank you for your time spent taking this survey.
Your response has been recorded.

Appendix C

Participants Interview Data

Interview question 1

Survey data indicates that a significant number of evidence synthesis researchers in the biological sciences are confident in their abilities to conduct evidence synthesis research. Is this your experience?

Participant #1

Although evidence-based research training experiences are as diverse as any academic training program it is not surprising that researchers and research teams don't need to be certified or align with CEE-like organizational standards. Lead researchers as faculty with years of experience are never the most enlightened people when attempting to complete new research projects with new methodologies. This is why science in our field of study is done with teams of researchers to include senior faculty, postdocs, staff and a multidisciplinary team of graduate students. These studies add to a body of knowledge that is quickly growing benchmarked by a full range of journals, conferences, colleagues, peers and editorial control. It is the responsibility of research teams to be qualified, meet disciplinary standards and face the wrath of scholarly peer review. With the emergence of so many journals willing to publish anything the push for quality and minimal bias in finished manuscripts is a team effort. Evidence synthesis like any scholarly process is directly affected by the quality of data captured, range of the body of evidence, experience of researchers in this field, and the desire to provide appropriate assessment. Too many research teams get away with asking great research questions, then get nabbed when attempting to answer these with low quality data, interventions and lack of strong research designs. Being confident in evidence-based research in environmental and biological applications takes time, energy, patience, and the ability to see low quality for what it's worth. As is with health studies evidence-based research, biological and environmental researchers should seek better standards that are required for publication. This would take our research community to push for these standards over time if only to improve the quality and impact of research on decision-making.

Participant #2

This is good to hear! Yes, this is my general experience with those familiar with evidence synthesis. However, I do believe their level of confidence might differ depending on the type of evidence synthesis. I'm sure most are familiar with and confident in their abilities to do a traditional literature review. However, they may be less familiar (and thus less confident) with a true systematic review approach (with or without a meta-analysis) or even more so with a systematic map approach.

Participant #3

I find that researchers that know what systematic reviews (protocol, steps, processes, etc.) are quite knowledgeable. Most of my experience has been with researchers that attended the training workshop I was a part of or are students that I train with the assistance of the [redacted] librarians.

Participant #4

No, I wouldn't say that I am confident in my abilities to conduct evidence synthesis given there are various types of syntheses, databases, protocols, screening approaches, etc. I also think a lot of the times, students are involved in these evidence synthesis research and they are also not confident in conducting this kind of research. Challenges often occur when developing deciding on type of synthesis, search strings, when scoping the synthesis and managing tradeoffs between time/resources and comprehensiveness. I often find systematic reviews the most difficult because of the rigid protocols and ensuring we are doing it right can be intimidating.

Interview question 2

What training strategies should researchers take to improve the quality of biological evidence synthesis research?

Participant #1

A good question. Teams should have to submit proof of training and completion of CEE, PRISMA, JBI… and related checklists. This could be a requirement for publication. Yet there are few opportunities to complete this certification either in person or online. Ultimately, graduate students should be encouraged or required to produce this certification as part of their coursework.

Participant #2

Great question! There are fantastic FREE online methods training courses for evidence synthesis available from the Collaboration for Environmental Evidence (CEE) https://environmentalevidence.org/training-2/. Seek help/guidance from Research Centres that specialize in evidence synthesis e.g., Canadian Centre for Evidence-Informed Conservation https://canadiancebc.com/. Full list of official CEE centres available https://environmentalevidence.org/cee-centres/. Read recent (quality) evidence syntheses. Syntheses published in, for example (but not limited to) CEE's flagship journal Environmental Evidence https://environmentalevidence.org/journal/, or Ecological Solutions and Evidence (stage 1 and 2 reports) https://www.britishecologicalsociety.org/content/ecological-solutions-and-evidence/, or Biological Reviews https://www.cambridgephilosophicalsociety.org/publications/biological-reviews. If available to the researcher, engage with a librarian for help with article searching and retrieving.

Participant #3

I think workshops and having librarians available to help guide the process is very helpful.

Participant #4

I am not aware of formal training strategies, but evidence synthesis centres often have training webinars and resources. Working with librarians would be critical, and working alongside a mentor with extensive experience in evidence synthesis can be another form of training strategy.

Interview question 3

What value does evidence-based research bring to the biological and related sciences?

Participant #1

Evidence-based ecology, conservation and environmental management is relatively new. The body of evidence is slim at times, the quality of studies is suspect, and resulting studies aimed at government bodies is so new for most decision-makers they don't know what to do with it. This is the difficulty of this type of research where it is welcomed by health-related fields but is left on the shelf in biological studies. This will take time to turn this culture around. There is an important role for evidence-based research designs to create effective interventions over a wide swath of biological, ecological and conservation issues. The advent of climate change, invasive species, destruction of habitats, biological markers for change… are a few issues where evidence-based research is needed if we are to pursue value in making right decisions.

Participant #2

Well, this is a loaded question…there is SO much value! I will try to keep my response brief and focused on evidence-based/informed syntheses (rather than research in general). Value of evidence syntheses: They provide a summary of the evidence on a topic (what is known), and if done well, this will be a comprehensive, unbiased summary. Use them to compare to previous findings or older syntheses. Identify potential areas for future primary research (what is currently not known to help inform research agendas). Identify deficiencies in the primary research so we can make recommendations on how to improve primary research in future (if a study validity assessment is done through a Critical Appraisal process). Conversely, this process will identify high-validity evidence (which studies we can trust!). Helps avoid duplication of research efforts (cost effective). The main value of evidence syntheses is that the results can be used to inform decision- makers of the implications of the best available evidence and enable them to place this evidence in context so that they can decide on the best course of action. Authors shouldn't offer advice.

Participant #3

It brings rigor and transparency to what the researchers are doing and communicating.

Participant #4

This question is also a bit tricky because what defines evidence is not considered in the question, and so I am not quite sure how to answer. Here are some thoughts... In a crisis discipline like conservation science, synthesizing evidence and ensuring we understand the effectiveness of interventions based on these syntheses are important. Evidence-based research can support effectiveness and efficiency of decision making.

Interview question 4

Have you considered bringing a librarian on to your next evidence synthesis research team? If so, what would this look like?

Participant #1

Not sure if librarians are trained in discipline-specific research designs to offer workshops and training of interest to emergent researchers as new faculty, postdocs and grad students. Carving out training may look like videos and case studies on tricky and sensitive issues. These may include bringing together different research teams to learn more about standards – why they are important? Grey literature sources – what do I need to know? Databases that use AI, provide sources apart from common sources e.g. Scopus and help to find international, non-English language, and essential studies – what don't I know that I should to produce high quality research? Training in R, statistical computing, data visualization, and stats, ROSES, literature searching with a non-health biological emphasis, Covidence – if we have this software, PRISMA for biological studies, team up with trained researchers to offer workshops and create learning aids in a timely manner. How to search for comparators when attempting to describe evidence-based research. Lots of opportunities.

Participant #2

Yes, and I have in the past! On the first couple of systematic reviews I was leading, I engaged with a librarian at my institution. I was fortunate to find a librarian that had direct experience with systematic and scoping reviews (albeit mostly in the health care field rather than environment/conservation space) but they helped immensely with the development of our review search strategy and search string development. These trainings and lessons have informed all our subsequent syntheses.

Participant #3

I am not in the process of doing a review, but I have all my students do one and they usually use the [redacted] librarian consultation. The level of involvement depends on each student in terms of their interaction with the librarian.

Participant #4

Yes, we've done this in the past. I have had graduate students work directly with librarians to select the type of synthesis is best for the question, confer on search string, and get advice on databases to use. Our librarian provided worksheets to help with search strings but also walked us through the pros/cons of certain databases as well as highlighting pitfalls to avoid.